Power Plant ENGINEERING

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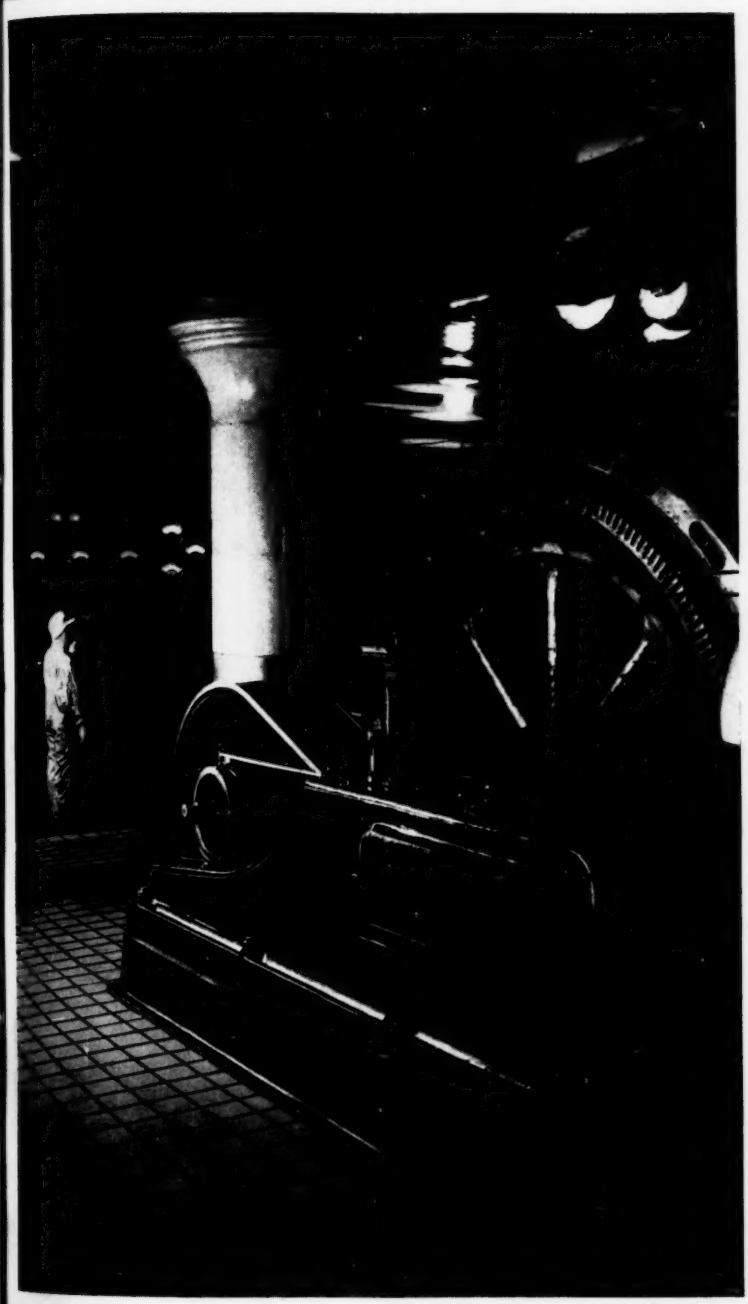

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COVER: 428-KVA ENGINE-GENERATOR THAT HELPS CARRY POWER LOAD AT CHICAGO PLANT OF WM. WRIGLEY, JR. CO. THIS UNIT HAS BEEN IN CONTINUOUS OPERATION SINCE 1913.

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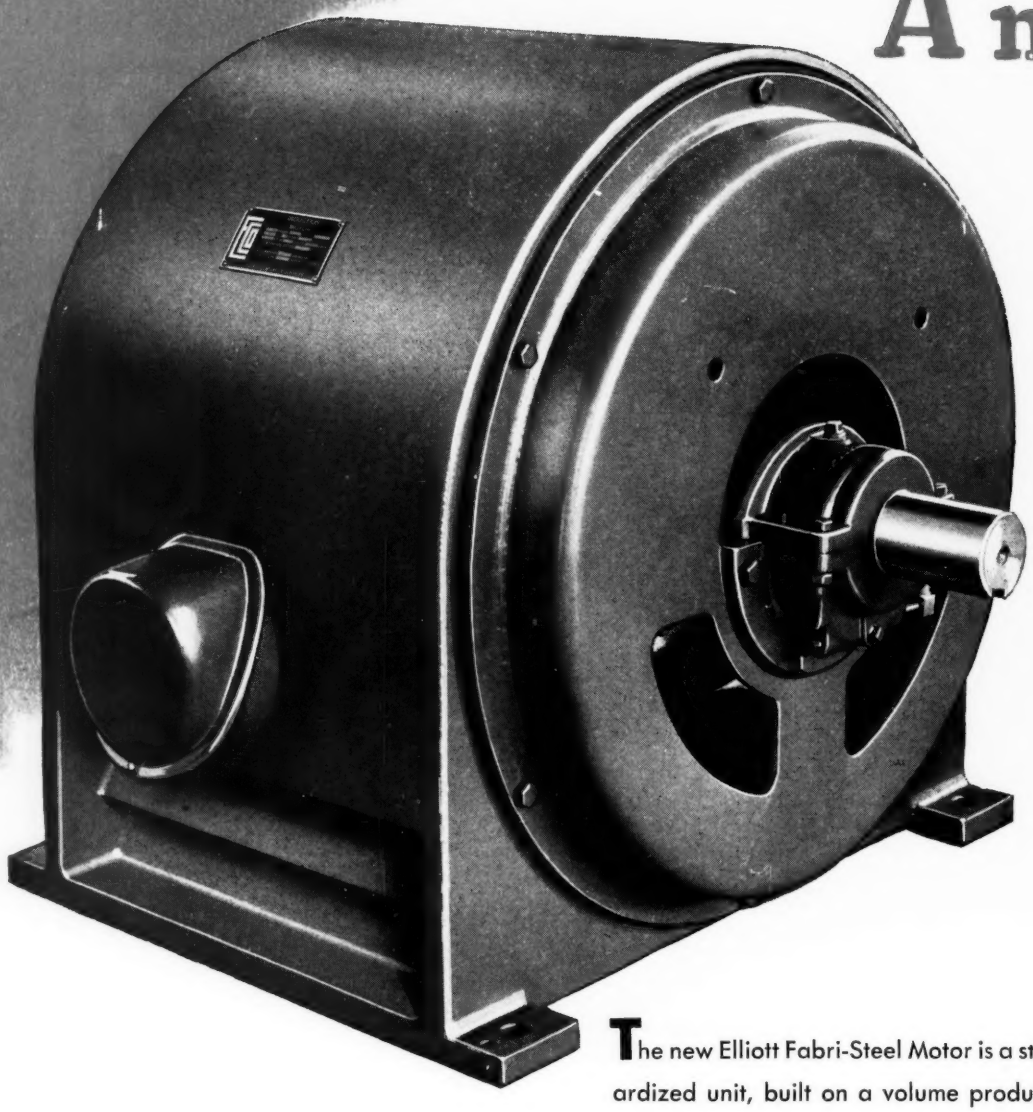
THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

MARCH, 1947

A new



The new Elliott Fabri-Steel Motor is a standardized unit, built on a volume production scale. Five frame diameters cover all standard ratings from 150 to 1000 hp, 4 to 14 poles. Dripproof sleeve bearing squirrel cage induction type illustrated above.

Elliott

XUM

Power Plant ENGINEERING

March, 1947

VOLUME 51—NUMBER 3

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50TH ANNIVERSARY

CELEBRATING 50 YEARS OF SERVICE TO THE POWER INDUSTRY

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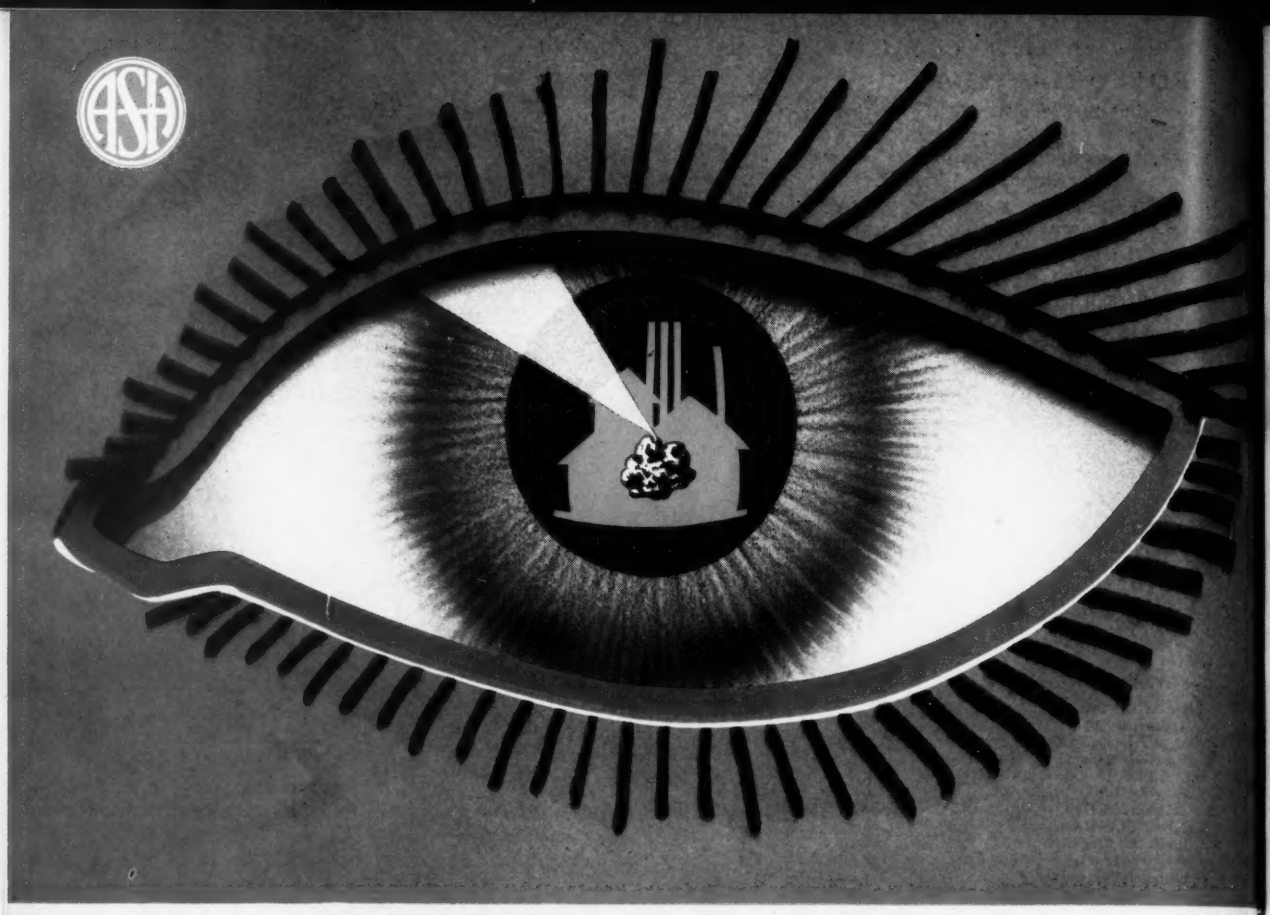

DUST HANDLING

is as much a Problem in a Power Plant as In Your Eye

We believe you'll get as much relief in discussing your power plant dust removal problems with one of our engineers, as you secure with the experienced skill of an expert, when you have a dust removal problem in your eye. We have every modern method to offer, in fact, we developed them. Hydrovac or Hydromix Systems solve every dust removal problem and please bear this in mind: the new Automatic Hydrovac is not a time saving luxury; it's a cold cash necessity. The Allen-Sherman-Hoff Co., 233 S. 15th St., Philadelphia 2, Pa.

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XUM

ENGINEERS' PREVIEW

TELEVISION in the power plant! A sight transmitting system, the Utiliscope, developed by Farnsworth Television & Radio Corp. and Diamond Power Specialty Corp., is being used at the Hell Gate Station of Consolidated Edison Co. of New York, Inc., to transmit water column indications from the column at the boiler drum level to a central control room 325 ft away. Ever since the development of such steam generating giants as are installed at Hell Gate Station, described in POWER PLANT ENGINEERING, November, 1945, a vital problem has been to bring the reading of the water level gage down to the operating floor or to a central control panel. In such boilers, water level indication is of vital importance because of the relatively small amount of water in the drum as compared to total circulation. The manufacturers of instruments and controls have done a great deal of effective work in producing remote water level indicating and recording instruments. They face problems such as separation of the boiler and main control room by several hundred feet and by six or eight levels of gratings or concrete floors, a building wall, piping, stairways, and other obstructions. The Utiliscope performs this job by means of a television camera focused on the water level gage and continuously transmitting the image of it to a television screen mounted on the central boiler control panel 325 ft away from the water column as reported recently in the *New York Herald Tribune*. The Utiliscope may also have many similar applications in observing coal feed to pulverizers or stokers, emission of smoke from stacks, condition of pipeline and pumps, readings of all sorts of instruments throughout a plant. Furthermore, the applications may include observation of gages and experiments and dangerous processes, for example, those involving radioactive substances.

★ ★ ★

SERVO-MECHANISM for control of power factor is described and illustrated in great detail by George C. Barnes, Jr., in *Engineering Experiment Station Series No. 63*, published by the Virginia Polytechnic Institute. This describes how the control is carried out by using two specific units of equipment employed extensively in the servo-mechanisms developed for military use. These two are the "synchro differential" manufactured by G. E., Bendix and Westinghouse under various names and the oil gear manufactured by the Oil Gear Co. and usually referred to simply as the M-1 oil gear. These devices are arranged in such a way that the synchro differential can be caused to give a torque which is directional with respect to either a leading or lagging power factor, referred to an initial zero setting of the synchro. If this torque is then applied to the control lever of the oil gear, the output of the oil gear is a great amplification of that torque. To apply this to the actual correction of power factor, the torque should be applied to the excitation of a synchronous motor or condenser or snychronous converter in such a way as to correct the error measured by the synchro. Elimination of the error should eliminate the torque and leave the system stabilized at the desired power factor.

PLANS are going forward for a large commercial scale Synthol plant in the Hugoton, Kansas gas field, to be built by Stanolind Oil & Gas Co. The plans call for the processing of 100,000,000 cu ft of gas per day, producing approximately 6000 barrels of gasoline and 1000 barrels of distillate fuels. The plans call for construction of an extensive pipe line gathering system; a natural gas plant; a very large plant for fractionating of liquid air into oxygen; a refinery for the recovery and treatment of hydrocarbon porducts; and a pipe line to transport finished products. The Synthol process is based in part on the German Fischer-Tropsch synthetic principle.

★ ★ ★

RUSSIANS Drill Hole 20 Miles Into the Earth. That headline over a story in one of the local newspapers, credited to the Associated Press, startled us a bit. The news item went on to explain that "Russian Geophysicists have drilled a hole 20 miles into the earth with an electric drill, the Moscow radio said tonight. The successful experiments near Leningrad show that electric drilling down to 30 or 40 kilometers (19 to 25 miles) can be achieved in two days. Until now, if it were at all possible, this would have taken several years." Whipping out our slide rules, we immediately tried to calculate what sort of metal such a drill might be made of and how it could be suspended that deep. So far as we could figure, none of the metals we know could possibly sustain its own weight in a cable or rod 20 miles long. However, the explanation came a few days later in an article in *The New York Times* commenting on the work of some of the prominent Russian scientists. The *Times* article describes how another recent Russian scientific achievement was the probing of the earth's crust to a depth of 32 kilometers, 19.87 miles by electrical sounding. This was done by a team of geophysicists of Leningrad University and produced valuable data for scientists seeking to judge mineral wealth. Professor Yanovsky of Leningrad stated "Until now the earth's crust has been studied only to a depth of three to five kilometers. We know of only one instance when French scientists reached a depth of twelve kilometers." Mechanical drilling to such depth, even if it were technically feasible, would take several years and involve a tremendous outlay of money and materials. However, it is hoped that a great deal of the same information can be obtained by electrical sounding.

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TO ASSIST in making more readily available the vast amount of business and technical information compiled by our U. S. Department of Commerce, the Bureau of Census has just issued a Subject Guide to Census Publications from January to June 1946. This gives considerable detailed information about individual publications of the Bureau covering specific subjects. Many of these are of general business interest such as those on population, others apply to specific industrial problems or products or scientific investigations. For example, you will find data on engines and turbines, on utilities, on boilers, on stokers, etc., particularly as they relate to numbers of units sold or ordered.

AN EXTENSIVE project, expected to continue for 8 or 10 years and greatly increase our knowledge of heat transfer and fluid flow in artificially roughened pipes, is now underway at Technology Center in Chicago. Its objective is a complete grasp of turbulence and the part it plays in fluid flow and heat transfer. The problem is in general still unsolved and much work is needed to explain the following phenomena completely. (1) Picking up and transporting solid particles as silt in a river or dust in the air. (2) Transfer of heat through a fluid. (3) Mechanism of dissipation of mechanical energy into heat by turbulence. (4) Development, propagation and decay of fluid turbulence. (5) Effect of turbulence on accuracy of fluid measuring devices. (6) Energy losses through pipes and fittings. Any industry that deals with the transportation of fluids or is interested in the production of equipment for fluid flow or heat transfer can profit from the increased knowledge that will be obtained in this research program. It is described and illustrated in considerable detail, with an analysis of some of the specific projects to be undertaken, in an article by Ralph G. Owens, Professor of Mechanical Engineering, IIT, in *The Frontier* for September 1946.

★ ★ ★

SALIENT statistics on Brazilian metals and minerals are given for 1945 and in some cases for the first half of 1946, in the November 20, 1946 issue of *Mineral Trade Notes*, published by the Bureau of Mines. There is some special information regarding quartz crystal and mica. Details are given on the new Brazilian Constitution, which apparently looks more favorably on foreign capital participation; and a special supplement presents the Brazilian mining laws of January 29 ,1940 including amendments. The report also reviews data on non-metallic minerals in Japan and Korea. It also gives a comprehensive report on nickel in Japan.

★ ★ ★

IF YOUR DROOLING mechanism is in working order, it certainly will percolate, as ours did, when we saw the first detailed announcement of the Maxson "miracle meals" now offered to the public by Macy's in New York. You will remember that we called attention to them and the way they have been used by the airlines in *Front Lines* of September, 1946. After the food has been cooked, these complete meals are assembled on a special heat-resistant plastic-covered plate and then the whole thing is quick-frozen. All you have to do to get it ready to eat is put it in an oven and heat it up. Afterwards—and now let us rise and sing the National Anthem—you just throw the plate away! Considering that it is a new development, the prices are not too bad either, compared with all other prices today. For example, here is one complete meal:—Sliced Pot Roast of Veal with dressing and gravy—peas with butter sauce, mashed sweet potatoes—82 cents. Or try this one:—Filet of Boston Blue-Fish with bouillon sauce—peas with butter sauce, French fried potatoes—98 cents. Of course, if you want sirloin or tenderloin steak you've got to pay nearly $2.00 for the ensemble.

★ ★ ★

GENERAL Subject and Author Index of Proceedings and Bulletins for 1935 and 1944 inclusive has recently been issued by the National District Heating Association, 827 N. Euclid Avenue, Pittsburgh 6, Pa.

DON'T RUIN paint brushes, they're expensive. Don't leave them soaking in water. Don't stand them on the bristles. Don't allow paint to harden in the brush—clean it properly after use with the proper thinner for the paint used. Finally, wash it gently with mild soap suds and water and rinse in clear water. Then comb and brush the bristles straight, wrap carefully and permit it to dry without disturbing or bending the bristles. These are the six elementary rules given in *Pittsburgh People*, Vol. 7, No. 10-11, along with a good deal of other practical comment on how to handle paint brushes. Good brushes are not too readily available now, says the article, and prices are not what they were.

★ ★ ★

FIRST ISSUE of *Federal SCIENCE PROGRESS*, a new monthly magazine covering the field of Government-sponsored scientific and technological research, has just been published. Edited for businessmen rather than technically trained readers, the magazine is published by the Office of Technical Services, Department of Commerce. The first issue is dated February, 1947. The leading article in the first issue describes a method of making rapid surveys of the soil conditions on construction sites by the use of aerial photographs. A German process for synthesizing petroleum fuels from coal and coke—the Fischer-Tropsch process—is described in a story by L. L. Newman of the Bureau of Mines. Mr. Newman studied this process as a member of the Government's Technical Oil Mission in Germany last year. Two plants using this process are now under construction in this country. Casper W. Ooms, U. S. Commissioner of Patents, in a story on the London Patent Conference, tells of the accord reached on the disposition of German-owned patents. The man who designed Boulder Dam and Grand Coulee, John L. Savage of the Bureau of Reclamation, is the subject of a profile by Murdoch J. McLeod. The story includes details of the work that Mr. Savage is now doing on the projected giant dam on the Yangtze River in China. Other subjects in the first issue include: solar heating of houses, weather and industry, a new cargo crane to speed the loading and unloading of ships, the use of models in technical training, the development of an agar industry on the South Atlantic coast, a new mechanical principle for the transforming of rotating into reciprocating motion, a simple and positive detector for poisonous carbon monoxide gas, and a number of German technical developments now available to industry in this country. Single copies of the magazine and annual subscriptions are available through the Superintendent of Documents, Washington 25, D.C. The subscription price is $3 a year, single copies 25 cents ($4 and 30 cents abroad).

★ ★ ★

FROM WAR TO PEACE is the title of a recent 75-page Report to the President, by John D. Small, head of the Civilian Production Administration. It contains a detailed review of the various problems involved in the work of CPA in demobilizing the controls that had to be put on American industry during the war. One of the most interesting features of the report is detailed discussion of various phases of both the durable and consumer goods industries, accompanied by charts of production, prices and requirements since V-J Day in 1945.

(Continued on page 182)

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILERS

1 **Boiler Bulletin**—This 4-page buletin describes the company's packaged water tube steam generator. Ease of installation of the unit is emphasized and its compactness and efficiency are pointed out. One of the illustrations in the bulletin is used as a medium for pointing out the various parts of the boiler. Illustrations and listings of other products in the company's line are also included. Heilman Boiler Works.

2 **Steam Generators—Facts and Figures**—Twelve pages in this catalog give operating figures and data on the company's steam generators and on installations of the units. Charts show how the modulating system continually adjusts the firing rate to the load demand. The simplicity of the installation is portrayed and data sheets (comparing three weights of oil) show the efficient performance and comparative fuel costs. A straight line chart and a worked-out example highlight this section. Typical user comments, typical installation, features of economical maintenance and tables of sizes and capacities round out the booklet. York-Shipley, Inc.

TURBINES, AUXILIARIES

3 **Steam, Air, Gas Turbines**—Bulletin 135-10 is a 12-page catalog which contains excellent engineering information and performance curves on steam, air and gas turbines. Facts to be considered in steam turbines are covered in the first two pages; these range from price considerations, design and construction to lubrication and governors. Three full pages of performance curves are preceded by a full page of instructions on how to use the curves. Sectional views of turbines and accompanying parts lists occupy two more pages in the bulletin. Coppus Engineering Corp.

4 **Deaerating Heaters, Vacuum Deaerators**—Bulletin 2 is a 4-page catalog describing the company's deaerating heaters and vacuum deaerators. The bulletin concisely outlines the applications and principles of operation of these units and explains the special advantages of this particular design. Blueprint-type illustrations are presented. Liquid Conditioning Corp.

5 **Heaters**—Heaters of all types are described in this 36-page Bulletin 200—instantaneous heaters, feed water heaters, storage heaters, heat exchangers, vapor condensers, surface condensers, heating system converters, domestic water heaters, swimming pool heaters, etc. Full pages of dimension tables are presented along with dimensioned drawings; pages of capacity tables for steam at various pressures from 0 psi gage to 100 psig also are given. Engineering information given includes tables of hot water requirements for various buildings, conversion tables for storage heaters, tank thickness recommended for various working pressures. The booklet is well illustrated. Alberger Heater Company.

6 **Tube Expanders**—This 6-page folder is a condensed catalog of sizes and prices of this company's line of boiler tube expanders. For instance, the first one covered —No. 16—is pictured and a brief description appears directly under the illustration. The table of sizes and prices gives information on the size of the expander in inches of outside diameter of the tubing, the size of tubing the expander will enter, the size to which it will expand the tubing, approximate shipping weight, and prices. Richard Dudgeon, Inc.

7 **Boiler, Heat Exchanger, Condenser Tubes**—This excellent 20-page bulletin BT-12-7500 covers the story of the company's condenser, boiler and heat exchanger tubing. A few of the chapter headings will indicate the extent to which the bulletin covers the subject: How to Specify; Maximum Allowable Working Pressure; Mechanical Tubing; Rail Carbon Steel Tubing; Specifications and Approvals; Stainless Steel Tubing; etc. The bulletin is exceptionally well illustrated throughout with both drawings and photos. Republic Steel Corp., Steel and Tubes Div.

OIL BURNERS, STOKERS

8 **Oil Burners**—This six-page folder presents complete information on six types of oil burners in the company's line. Tables of burner capacities and ratings are presented, a cross sectional drawing of one of the burners, a layout diagram of an installation and mechanical features all are given. General specifications of the units are presented on the last page. Typical installations are pictured. National Oil Burner Co.

9 **Stoker Firing Operation**—Single Retort Underfeed Stoker Firing is the subject of Bulletin Number 9 issued by this Bureau. It is a complete analysis of the advantages of the single retort stoker in the smaller plants. Types of this stoker are described and principles of operation are outlined. Selection of coal and the application and engineered installation of the stokers are considered at length. A maximum burning rate guide is included. An inset section of the bulletin shows four typical boiler unit designs with design data. Fairmont Coal Bureau.

PUMPS, COMPRESSORS

10 **Steam Driven Compressors** — Large steam driven compressors from 50 to 1500 hp are described in this 52 page catalog, Form 3444. A double-page spread covers "Important Points to Consider When Selecting a Steam-Driven Compressor." The next two pages present a cut-away drawing of the compressor with parts and advantages pointed out. All parts of the compressor are described in detail, often with a full page devoted to one part. Each part is illustrated with an excellent wash drawing. Many illustrations of typical installations are presented in the back portion of the booklet. Ingersoll-Rand.

11 **Centrifugal Pumps**—Here is a large six-page folder telling about the various pumps in the company's line and a brief description of the application of each pump. Illustrations are large and clear. Among the units covered are thick stock pumps, portable pumps, high pressure boiler feed pumps, vertical sump pumps, etc. Frederick Iron & Steel, Inc.

12 **Pump Data Booklet**—This new 20-page Bulletin B-159, titled, "Vertical, Close-Coupled Turbine Pumps," is devoted in its entirety to describing and illustrating specialized application of these turbine pumps to industrial, municipal, engineering and agricultural installations; emphasis is placed on installations where short pump settings are encountered and where there is a strong necessity for deep well turbine pump power and capacity. The bulletin is exceptionally well illustrated with sectional views of important integral parts of the unit and overall pictures; typical installations are also shown in many of the photographs. Blueprint illustrations are presented in the back portion of the booklet to illustrate settling and recirculation, boosting, cooling, air conditioning, sump service, and general purpose. Details of pump engineering, construction and operation are fully described and illustrated. Peerless Pump Div., Food Machinery Corp.

13 **Pump Governor Data Book**—Engineering, operating and maintenance data on pump governors are included in this 16 page illustrated booklet, Bulletin 463. Included are capacity tables to aid in the selection of the proper pump governor for specific applications. Specifications, sizing information, installation and operation instructions are presented with accompanying illustrations. Recommended procedures for dismantling, cleaning and assembling of the governors are outlined. Construction details of each class of bronze and steel governor are given and large, cross-sectional color views clearly show outstanding features. Leslie Co.

INSULATION

14 **Insulation Data Book**—The large proportion of this 16 page booklet is devoted to tabular material and engineering information. Typical of this material are tables and guides with the following heads: Industrial Insulations — General Selection Guide; Heat Insulation—Condensed Specifications; Selection Chart for Determining Insulation Thickness; Properties of Saturated Steam; Cements Selection Guide, etc. In addition to data of this type there is presented complete information on all types of insulations in the line—from diatomaceous earth and cold water insulation to steam and water insulation. The bulletin is well illustrated with charts and photos. The Philip Carey Mfg. Co.

15 **Legends of Asbestos**—Here, in 20 pages, is an absorbing history of the use of asbestos throughout the ages. One of the legends tells how Charlemagne washed his tablecloth in fire and how this seemingly simple trick saved his empire from the forces of Haroun El Raschid. Marco Polo, too, was amazed when he discovered asbestos cloth in the court of China's Khan; he thought it was the skin of the famed salamander, a creature reputed to live in fire. Each of the legends is accompanied by an excellent illustration. Keasbey & Matison.

16 **Insulations Manual**—Industrial insulations and a huge amount of engineering information on heat losses, dimensions, etc. are presented in this 20 page booklet. Application data is presented in boxes on many of the pages; this includes excellent line drawings which are almost self-explanatory, plus tabular information. Typical tables given in the booklet are: Thermal Conductivity of Materials; Heat Losses from Iron Surfaces; Effect of Windage; Conversion Factors; Table of Dimensions. The book is extremely well illustrated with photos, drawings and charts. The company's products are thoroughly described, covering everything from thermal conductivity to methods of packaging. The Eagle-Picher Co.

LUBRICATION

17 **Lubricania**—The hundreds of specialized lubricants in use today are identified by certain commonly used tests and terms which describe their physical characteristics. In this dictionary of terms, tests and values, the company has highlighted the most important of these. For example, under "Viscosity" the definition is first given, then the test for viscosity is explained and an example is given. Equipment used in the tests is pictured. In some instances the significance of the term or test is explained. Tide Water Associated Oil Co.

18 **Lubrication Procedures**—"Lubri-Chaos" is the term applied by this firm to the irritating problems faced by many plants today when they must use innumerable lubricants at varying intervals and when the responsibility for such lubrication is divided. The booklet shows examples of how Lubri-Chaos caused expensive breakdowns of equipment and unduly high costs of lubricant. It then develops the story of how Lubri-Chaos can be avoided and shows how "Colorouting" of the lubricant from the barrel to the bearing prevents misapplication, over-lubrication and under-lubrication; how it reduces the number of lubricants and oils required from

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POWER PLANT ENGINEERING

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30 to 75 per cent; enables inexperienced help to do the lubrication jobs expertly. The booklet is printed in four colors to correctly interpret the significance of the method and the explanation is rendered easy to understand by the skillful use of colored drawings and color superimposed on photos. Alemite Division, Stewart-Warner Corp.

ELECTRICAL

19 **Electric Fish Screen**—This positive, harmless barrier to all fish is shown, in this bulletin, to solve a highly vexing problem for power and industrial plants whose condenser and process intake screens are forever being clogged by countless fish. The bulletin pictures installations in many places of this type and explains how the screen operates, tells of its low cost and ease of installation. No cleaning of the electric screen is needed, it is pointed out, because the system is made up of swinging electrodes which allow debris to pass but which turn fish back due to an unpleasant stimulus imparted by the current wave. The three parts of the system are pictured and described. Electric Fish Screen Co.

20 **Coil Rewinding Magazine**—Published at frequent intervals is "Coil Talk," an excellent little publication devoted to technical information, trade talk, hints, photos and announcements of other bulletins, data books, catalogs and activities of this company. The magazine is published by a concern whose sole job is the rewinding of coils for generators, motors, etc. Anyone wishing to have his name placed on the mailing list for this publication will receive it free of charge. National Electric Coil Co.

21 **Insulated Wire Technical Bulletin**—This detailed Technical Bulletin H-407 on Insulated Aluminum Building Wire has just been issued. In addition to tables of capacities, comparative weights and data on characteristics it includes an insert which gives quick methods of determining voltage drop, conductor sizes, circuit length and currents for both aluminum and copper. The bulletin also points out how fittings manufacturers have developed suitable connectors and terminal lugs for use with aluminum conductors. The Okonite Co.

22 **Renewable Fuses Booklet**—"The Inside Story of Trico Renewable Fuses," is the title of this 24-page booklet, 206-A. Extensively illustrated with drawings and charts the booklet shows in detail the value of the "powder-packed" principle in renewable fuse design. Not only is the bulletin quick reading but it also gives much helpful information for increasing production by eliminating unnecessary shutdowns, how to get maximum protection for your more expensive equipment, greater safety against fire and accident hazards. Trico Fuse Mfg. Co.

23 **Power Factor Regulation**—This bulletin describes the Haug System of Power Factor Regulation and what it will do for the average plant. Among other things it points out that it will increase the power factor as desired, the monthly power bill will be much less and a substantial saving in man hours will be affected. Among the points considered in the bulletin are: power factor and energy costs, definition of power factor, causes of low power factor, what the Haug System Power Factor Regulator Does. Line diagrams show the significance of the unit. Construction of the regulator is outlined on the last page. Modern Control Equipment Co.

INSTRUMENTS, CONTROLS

24 **Steam, Liquid Control**—Catalog 47, describing Steam and Liquid Control Equipment contains 48 pages. Described in the catalog are valves, precision pressure regulating, relief and float; temperature regulators; self-cleaning strainers; water gages, gage cocks; illuminators; steam traps, air separators; etc. Included in the book are information on dimensions, application, capacity of equipment, list prices, engineering tables and specifications add to the usefulness of the booklet. O. C. Keckley Co.

25 **Instruments Catalog**—This new Catalog 646, 32 pages, describes the complete line of instruments ranging from safety controls and alarm systems to special indicator systems and automatic plant equipment for internal combustion engines and industrial applications. Each type of control is completely described and individual units in that particular classification are also pictured and described. Ratings, application, operation, construction and design are thoroughly covered. Viking Instrument Co.

26 **Electric-Type Flow Meters**—Bulletin 46-800 is a 20-page bulletin covering this company's friction-free flow meter. A general description of the unit and the reasons why its high accuracy are important are first presented; the catalog then goes into a detailed analysis of the parts and workings of the individual parts of the meter. Adaptability of the unit to various metering problems is explained. The entire booklet is exceptionally well illustrated with line drawing, charts and photographs. The Hays Corp.

27 **Speed Indicators**—Bulletin 1815 is a four-page bulletin covering new models of the company's Jagabi speed indicators or chronometric tachometers. These instruments are now available in a variety of ratings up to 100,000 rpm. Besides picturing the instruments the bulletin tells of their speed ratings, operation and counting mechanisms. Tabular material presents specifications and lists of accessories. James G. Biddle Co.

28 **Steam, Air, Gas Meters**—Bulletin 349, 8 pages, covers the company's Shuntflo meters for steam, air or gas metering. Explanations of operation, charts of accuracy, wash drawings of both interior and exterior of the meter are shown. Blueprint illustrations of installed meters present helpful information. The last page of the folder presents a full page table of capacities for a few of the many operating conditions under which the meter may work.—Builders-Providence, Inc.

FANS, BLOWERS

29 **Blower Systems**—Indicative of the type of blower systems which this company has installed in power plants and industries across the country are the wood working blower systems described and pictured in this 28-page, spirally-bound bulletin. Analyses of the conditions in the plants and capacities of the systems are told in nearly every case and excellent photographic evidence of the installation is presented. The Kirk & Blum Mfg. Co.

30 **Dust Recovery Cyclones**—There are 8 pages in the folder telling about Buell cyclones and their use in industrial dust recovery systems. Simple but excellent line drawings are used to point out many of the operating principles mentioned in the text. The booklet was prepared under the direction of the company's testing laboratory. Buell Engineering Co.

SPECIALTIES

31 **Steam, Power Specialties**—Bulletin No. 715 is a four-page catalog which lists and briefly describes many of the specialties in the company's line of equipment. Included, for instance, are oil separators, steam separators, steam traps, high and low alarm water columns, boiler signals, etc. Each of the items is pictured and a brief description is presented. A tabbed page contains a coupon which may be used to request detailed catalogs on each of the specialties described. Wright-Austin Co.

32 **Manual of Specialties**—Catalog 48 is a 50-page bulletin, bound in a separate heavy paper cover. It describes and illustrates practically every specialty in the power plant, from water columns, flanges and floats to gages, glasses and gaskets. Complete dimensional specifications are presented in tabular form for each piece of equipment and illustrations of the units are large and clear. Direction for assembly and installation of the specialties are given in some cases. Ernst Water Column & Gage Co.

POWER TRANSMISSION

33 **Couplings Manual**—Catalog 47, 52 pages, is a spirally bound booklet which covers principles of operation, design and installation of self-aligning couplings. Solving errors in alignment, principles of lubrication, types of couplings, full-page sectionalized and exterior views of the couplings, pages of ratings and dimensioned drawings are a few more outstanding features of the catalog. Bartlett Hayward Div., Koppers Co., Inc.

34 **Belting Data Book**—Application and operation of this company's leather V-belting is covered in a recently issued four-page folder. Sketches and description show how to measure proper lengths of belting, how to cut for proper tension, how to prepare belt ends and to attach couplers. "How to Check Your Drive for Proper Belting" is a section of the folder which presents a horsepower table and table of sizes. S. R. Sikes Co.

35 **Remote Transmission Systems**—Catalog 5902 is a new 24-page booklet on the company's pneumatic remote transmission systems for application where electrical transmission for indicating, recording and control of temperature, pressure, flow and liquid level is neither permissable nor desirable. The booklet is profusely illustrated and carries several schematic diagrams of typical applications. The systems operating features are fully explained and there is a comprehensive description of the parts which make up the system. One section of the catalog is devoted to accessories used in the systems. The Brown Instrument Co.

TREATMENTS

36 **Waterproofing Data Book**—"Aquella and Concrete Masonry Construction is the title of this 16-page booklet. The problem of water proofing this type of construction, especially when the masonry is under a hydrostatic head, has long been a problem. This material, used to waterproof the Maginot Line, is described in this bulletin and its application and advantages are outlined. Among the many questions answered in the book are: How many coats are recommended? How are surfaces prepared? How are cracks treated? How is Aquella applied? Where can it be used? Proof of how it withstands hydrostatic pressure tests of 500 psi is provided. Many "before and after" photos are presented. Prima Products, Inc.

37 **Fuel Oil Treatment**—Several bulletins have recently been announced by this company describing completely the application and effect of its fuel oil treatment compound and Diesel engine solvents. For instance, one of the folders describes in detail the advantages obtained from the use of the fuel oil treatment, describes its action and presents details of the company's guarantee. Another folder gives complete information on the action of this compound when poured into the oil in the crank case of a Diesel engine. Soot and slag remover is described in a fourth bulletin; its application to pulverized coal equipment is described. Wilcolene Mfg. Co.

VALVES, PIPE, FITTINGS

38 **Pressure Regulating Valves**—This new 8-page bulletin covers the company's line of pressure regulating valves of both the spring loaded and weight loaded types and also the pilot operated type. Features, construction and design of the valves are thoroughly described and line drawings are used to illustrate the points brought out and also are used to name parts. Other products described are a diaphragm type pressure regulating valve and an easy cleaning strainer. Kaye & MacDonald, Inc.

39 **Compressor Valves Data Book**—This company has made available reprints of an extremely detailed paper on "Automatic Valves for Ammonia Compressors" by J. H. H. Voss. Illustrations consist of indicator carc diagrams, gas velocity diagrams, sectional views of plate valve design, and many similar photos and sketches. Indicator card analyses are reported. There are 8 pages in the bulletin. J. H. H. Voss Co.

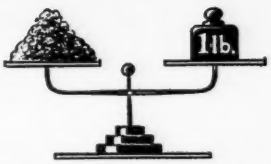
40 **Pipe**—"Pipe in American Life," is a 48-page illustrated booklet which presents the historical background and modern uses of metal pipe with emphasis on the use of steel pipe. Chapters are devoted to the use of steel pipes in homes, large buildings, process industries, railroads shopping, mining, water supply systems, the oil industry, the gas industry, refrigeration, irrigation and on farms. The illustrations in the book are exceptionally interesting and many of them have never before been published. American Iron and Steel Institute.

41 **Blow-Off Valves**—Blow-off valves for medium and low pressure boilers (up to 400 psi working pressure) are described in Bulletin B-424. Included in the bulletin are: construction details of the valves; physical and chemical properties of metals; prices, weights and dimensions; descriptions of the various types of valves; prices of parts; typical installations; research and manufacturing facilities, etc. The bulletin is illustrated throughout with excellent line drawings and photographs. Yarnall-Waring Company.

42 **Flexible Ball Joints**—This 8-page bulletin, Catalog 209, covers the company's line of flexible ball points for oil, steam, air, gasoline, water and other fluids where a flexible connector is required. Illustrations of each of the joints are presented and parts are also pictured. A full page of tabular material shows principal dimensions of each of the types of joints. Other types of joints are pictured in drawings and typical installations are shown in photos. Barco Manufacturing Co.

(Continued on page 164)

CAN YOU PREVENT THIS MUCH BOILER SCALE?



FOR THIS?

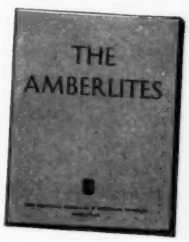
Amberlite Softening Treatment ends boiler scale at low cost!

Here's an end to costly boiler scale! Regardless of water supply or fluctuation in quality, you can stop boiler scale before it starts with the AMBERLITE ion exchange softening treatment.

By passing the raw water through beds of AMBERLITE Ion Exchange Resins the scale-forming magnesium and calcium ions are removed *before* the water enters the boiler— reducing supplementary phosphate treatment and lowering blow-down losses. Operating costs of the AMBERLITE treatment are low — the cost of regenerating the resins between cycles averages *less than one cent per pound of boiler scale prevented.*

Additional advantages of the AMBERLITE softening treatment are: complete softening; minimum maintenance requirements; low space requirements; simplicity and flexibility of operation; high throughput; uniformity of treated water supply.

Time-Tested Uses and New Ideas Worth Investigating



Our booklet "THE AMBERLITES" *suggests many applications for these time-tested Ion Exchange Resins—some applications already commercially established, others pointing the way to new fields of investigation. For your copy of this booklet, address The Resinous Products & Chemical Company, Department P-21, Washington Square, Philadelphia 5, Pa.*

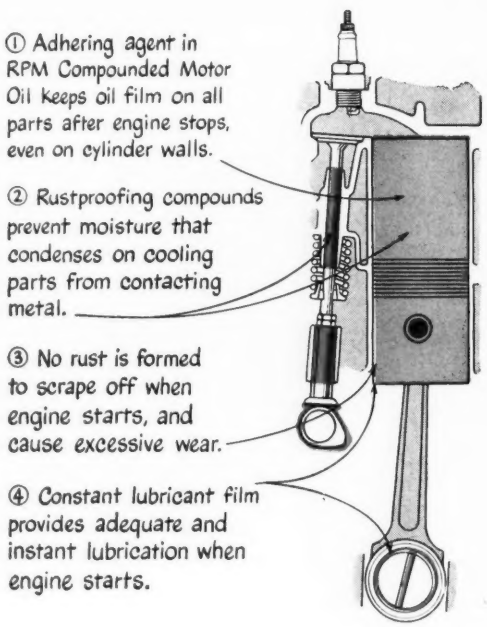
AMBERLITE *is a trade-mark, Reg. U. S. Pat. Off.*

THE RESINOUS PRODUCTS & CHEMICAL COMPANY

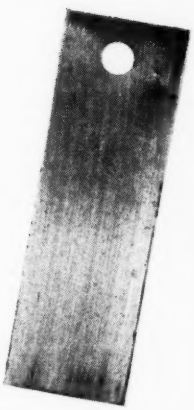
WASHINGTON SQUARE, PHILADELPHIA 5, PA.

STANDARD ENGINEERS NOTEBOOK

CALOL RPM


① Adhering agent in RPM Compounded Motor Oil keeps oil film on all parts after engine stops, even on cylinder walls.
② Rustproofing compounds prevent moisture that condenses on cooling parts from contacting metal.
③ No rust is formed to scrape off when engine starts, and cause excessive wear.
④ Constant lubricant film provides adequate and instant lubrication when engine starts.

This actual photograph shows how one HIGH-QUALITY MOTOR OIL "peeled" off almost all of this test strip of steel when it was placed in corrosive-moisture conditions similar to those in a cooling engine. The oil concentrated at one spot and the unprotected surface quickly rusted.



RPM COMPOUNDED MOTOR OIL kept this strip bright and shiny, completely sealed against rusting, when it was exposed to the same conditions. "RPM" compounds keep a constant rust-proofing lubricant film on engine parts at all times, whether they are idle or moving.

How RPM Motor Oil Rust-Proofs As It Lubricates

Rusting, caused by corrosive moisture, is the greatest source of wear in automotive engines (85%, according to some engineers). It can be controlled by using RPM Compounded Motor Oil.

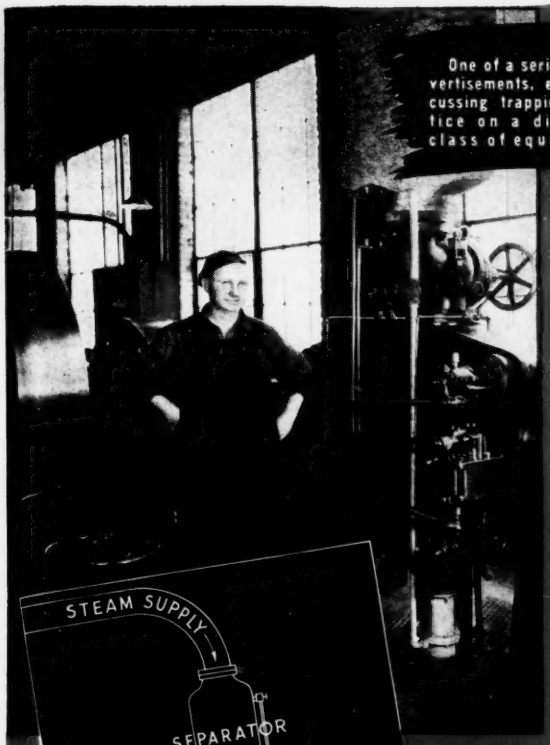
Additional compounding for "RPM," perfected by Standard of California scientists, provides a rust-proofing lubricant film on internal engine surfaces. The heaviest moisture condensation in idle or cold-running engines will not cut through it.

Other compounds in RPM Motor Oil give it adherent qualities so the film stays on parts at all times. They also loosen and remove gum and lacquer, lubricate hot spots, resist sludge formation, bearing corrosion and stop foaming.

Trademark "RPM" Reg. U. S. Pat Off.

For additional information and the name of your nearest Distributor, write Standard of California, 225 Bush Street, San Francisco 20, Calif.; The California Oil Company, 30 Rockefeller Plaza, New York 20, N. Y.; The California Company, 17th and Stout Streets, Denver 1, Colo.; Standard Oil Company of Texas, El Paso, Texas.

FOR EVERY NEED A STANDARD OF CALIFORNIA JOB-PROVED PRODUCT



One of a series of advertisements, each discussing trapping practice on a different class of equipment.

No. 223 Armstrong Special Trap draining engine separator, Kerber Packing Co., Elgin, Ill.

HOW TO TRAP STEAM ENGINE SEPARATORS

Special Armstrong Traps for Pulsating Pressures

THE PRESSURE pulsations set up by reciprocating steam engines present an extra hazard for the trap that drains the steam separator ahead of the engine. Armstrong offers two types of traps for this service.

Where the pressure pulsations are extremely rapid or when there is a wide swing between maximum and minimum pressure, use a standard trap equipped with internal check valve and extra heavy spring. The check valve will maintain practically constant pressure in the trap body, thereby minimizing wear on the trap mechanism.

If the pressure pulsations are moderate and not too rapid, use the 220 series trap in semi-steel for pressures up to 250 lbs., or the 320 series steel traps for pressures to 600 lbs. The 220 and 320 series traps have a separating chamber below the trap body for collecting condensate. When the chamber is full, a float check permits all the condensate to enter the trap proper and produce a wide-open discharge at rather long intervals even though a little water will enter the separator every time the pressure rises.

For complete information or specific recommendations see your local Armstrong representative, or write the ARMSTRONG MACHINE WORKS, 810 Maple St., Three Rivers, Michigan.

TRAPPING TIPS*

- Install trap below and close to separator.
- Avoid use of extended horizontal lines ahead of the trap.
- When throttle valve of engine is closed, keep line to trap open to prevent accumulation of condensate.
- Install trap with bypass.

*For complete data on condensate loads, trap safety factors and trap installation, ask for a copy of 36-page CATALOG H.

ARMSTRONG *Inverted Bucket* **STEAM TRAPS**

Over a Million in Use...For Power...Process...Heating

NEW EQUIPMENT NEWS

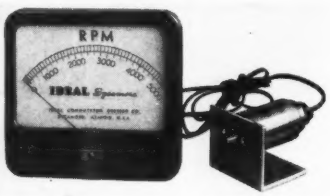
Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Illinois.

A Panel Type Tachometer

A new electric tachometer for permanent installation is announced by Ideal Industries, Inc. This unit is particularly designed for use where the "pick up unit" or generator must be mounted permanently on a machine, and the meter mounted on a panel far removed from the generator position.

The generator consists of a small, permanent Alnico magnet rotor mounted on precision sealed ball bearings and capable of continuous operation at any speed within the limit of the meter.

The meter or indicating instrument is a rectifier type, including a sturdy D'Arsonval movement. It is capable of withstanding a momentary overload up to four times the maximum speed indication without damage.



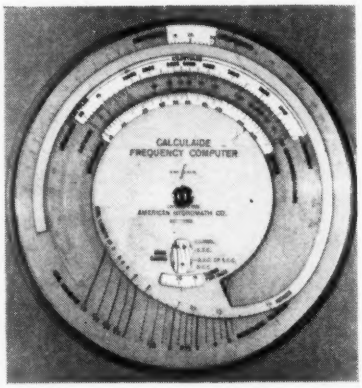
For installation up to 200 ft the unit may be connected with two conductor No. 18 insulated wire. For longer distances, it is recommended that the Ideal Engineering Department be consulted for proper size of conductor.

The meters are rectangular in shape and available in two sizes: 3 in., and 7 in. Both are available in three scale sizes: 0-1250 rpm; 0-2500 rpm; and 0-5000 rpm.

B Frequency Computer

Problems involving frequency, inductance and capacity are quickly solved with the "Calculaide" frequency computer devised by American Hydromath Co. This new frequency computer correlates, in one setting, the natural frequency and wave length of a circuit comprising a coil and condenser with the physical dimensions of the coil and the capacity of the condenser.

Since all answers are given at only a single setting, the computer greatly simplifies resonant circuit calculations. Inductance values can be determined for widely varying physical dimensions of coils, such as high-power transmitting coils or the smallest single-layer receiver coils.



The computer's range covers frequencies from 400 kilocycles to 150 megacycles and wave lengths from 2 to 600 meters. It handles condensers of capacity between 3 and 1000 micro-farads. Inductance values which can be determined extend from 0.1 to 1500 micro-henrys. The device performs calculations with coils of ¼ in. to 5½ in. diameter, ¼ in. to 10 in length. 2 to 150 turns per inch, of No. 10 to No. 35 gage wire, whether enameled, single or double silk covered. or single or double cotton covered.

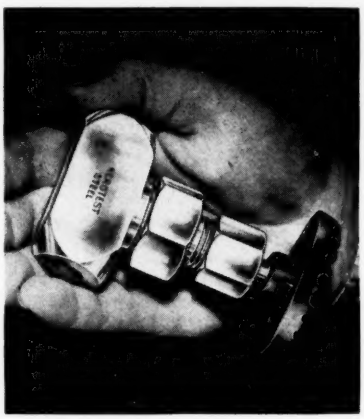
The Calculaide frequency computer is produced from three sheets of tough, nonwarping "Vinylite" plastic. All markings are indelibly heat-sealed into the body of the plastic itself. Only 6¼ in. in diameter, and semi-flexible, it can be conveniently carried in the pocket.

C Needle Valve

A new precision needle valve is announced by Kerotest Manufacturing Co. for gage and metering lines, instrument lines, test lines, bleeder lines, and other high temperature, high pressure, or corrosive services in chemical and food processing, refineries, power plants, mines, laboratories, utilities, and many other industries.

The new needle valve is reported to afford complete safety of operation. Union nut construction prevents dangerous blowouts during opening or repacking and also provides an extra deep stuffing box. Positive back seating allows the valve to be safely repacked under full line pressure. A metal-to-metal line seal at the bonnet eliminates the use of gaskets. Full port clearance prevents interference with flow characteristics by the nipples.

The new valve combines positive shut-off with micrometer throttling action. The ball seat, which provides a positive line seal for complete shut-off, has a tapered tip, actuated by fine stem threads, which permits control of flow and also ease of operation at all pressures. They are available in both globe and angle types in sizes from ⅛ in. to ¾ in. for working pressures



up to 3000 lb; temperatures up to 750 F. They are made from cadmium plated carbon steel, 12-14 per cent chrome—Type 416 or 18-8 stainless steel—Type 316—or special alloys to meet any desired specifications.

D Electrical Connector Kit

The new Hylug Connector Kit, just announced by Burndy Engineering Co., Inc., and available to industry through regular electrical wholesale channels, contains everything necessary for making small-wire solderless electrical connections.

The Kit contains 325 assorted Hydent connectors for conductors No. 20 through No. 10 wire; as well as a standard Burndy Hytool for installing the connectors. The connectors are packed in attractive and durable plastic jars as illustrated; containers which will withstand much hard usage.

It is pointed out that Hydent connectors are of pure-copper, one-piece construction, with no extra parts which might loosen and cause increased resistance. When these one-piece connectors are indented with the

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MARCH, 1947

POWER PLANT ENGINEERING

53 W. Jackson Blvd., Chicago 4, Illinois

Please have the manufacturers send me without obligation further information on the equipment indicated by the following letters:

.....
.....
.....
.....
.....

Please Print Clearly

Your Name .....

Your Title .....

Your Company Name .....

Company Address .....

City ..... State .....

(If you prefer delivery at your home also fill in below)

Home Address .....

City ..... State .....

DEPARTMENT OF TECHNOLOGY BUFFALO PUBLIC LIBRARY

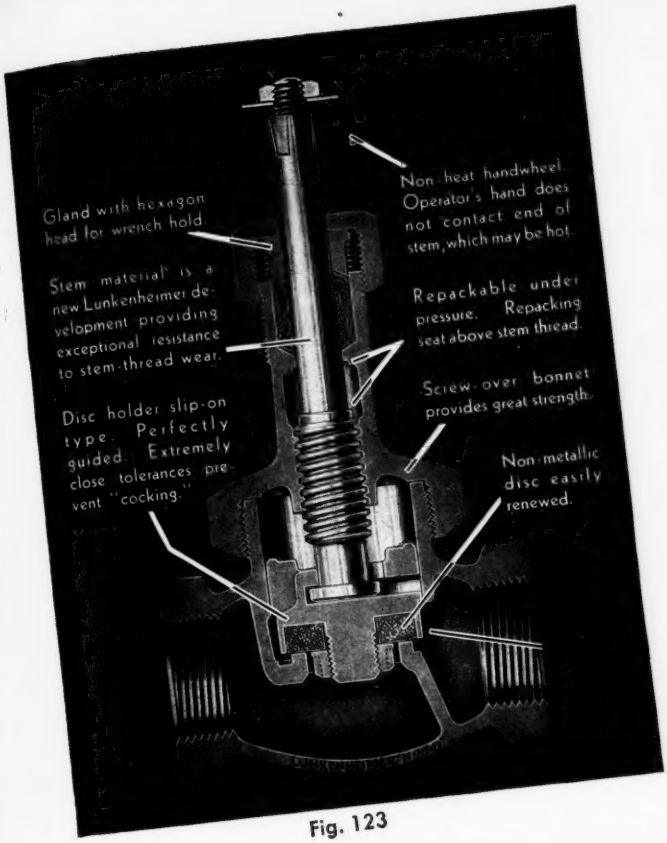

Gland with hexagon head for wrench hold.
Stem material is a new Lunkenheimer development providing exceptional resistance to stem-thread wear.
Disc holder slip-on type. Perfectly guided. Extremely close tolerances prevent "cocking."
Non-heat handwheel. Operator's hand does not contact end of stem, which may be hot.
Repackable under pressure. Repacking seat above stem thread.
Screw-over bonnet provides great strength.
Non-metallic disc easily renewed.

Fig. 123

NON-METALLIC DISC

The valve that saves time, trouble and maintenance

N-M-D VALVES

In Globe, Angle, Check and Quick Operating Types

ASK YOUR DISTRIBUTOR

He will show you how the N.M.D. can be renewed "P.D.O."

Send for this Circular

No. 558 available from your Lunkenheimer Distributor or write for copy.

QUICKLY RENEWABLE

The initials "N.M.D." designate LUNKENHEIMER VALVES equipped with NON-METALLIC DISCS. (One long-time user insists that the abbreviation means NONE MORE DEPENDABLE).

ELIMINATES REGRINDING

The N. M. D. Valve's unique design and construction provides for easy replacement of discs and the assurance of maximum tightness under all conditions. No regrinding necessary. In handling steam, hot or cold water, air, gas, gasoline, oil and other fluids, N. M. D. Valves deliver uninterrupted service on a "lower cost per year" basis.

THE LUNKENHEIMER CO., Cincinnati 14, Ohio, U. S. A. New York 13, Chicago 6, Boston 10, Philadelphia 7. Export Dept.: 318-322 Hudson St., New York 13, N. Y.

LUNKENHEIMER VALVES

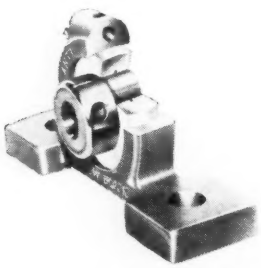
BRONZE, IRON, STEEL, AND CORROSION RESISTANT ALLOY VALVES
AIR DEVICES, LUBRICATORS, AIRCRAFT FITTINGS

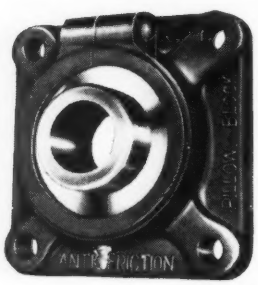
Hytool they are virtually 'coined' to the conductor, providing a connection high in mechanical strength and electrical efficiency.

The Hylug Kit affords contractors and industrial maintenance departments a compact and convenient connector assortment for all small wire installation and repair jobs.

E Pillow Block, Flange Unit

These new self-aligning bronze pillow blocks and flange units were announced recently by Anti-Friction Bearings Co. The split high-tensile strength aluminum housing is reported to carry a spherical Naval bronze bearing and a





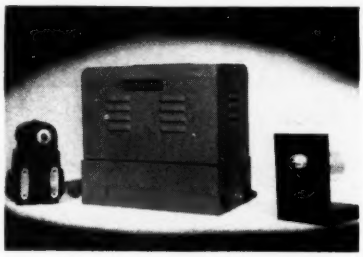
ground adapter sleeve is inserted in the bronze bearing so that one basic pillow block can serve a number of shaft diameters.

After the shaft has been located, housing is clamped on spherical self-aligning bronze bearing giving a rigid bearing for taking either radial or thrust loads. The line of bearings included sizes from 5/8 to 3 in. shaft diameters in both pillow blocks and flange units.

F Remote Control Servomechanism

This new servo is designed for remote indication or control. The servo consists of three units as pictured below (left to right): 1. Torque Unit; 2. Amplifier; 3. Control Unit.

The position of the shaft on the torque unit is controlled by the amplifier to correspond to the control unit. The system is sensitive to 1 per cent changes in the control unit which requires approximately 1 ounce-inch of torque for operation. The torque unit develops a maximum of fifty



pound feet of torque. The amplifier unit consists of three radio type vacuum tubes and associated equipment. A safety feature is provided in the signal light associated with control unit which indicates correct operation of system.

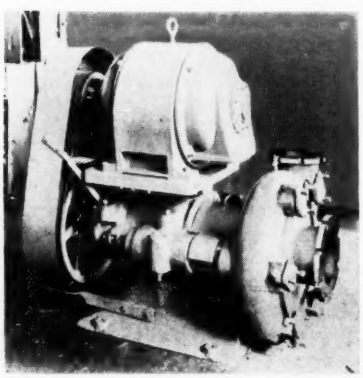
The system operates from 115-v 60 cycle power which is supplied at the amplifier. It is announced by G. C. Wilson & Co.

G Pump Handles Ash in Large Pieces

In a midwestern power plant the ash comes down in pretty sizable pieces, which would not pass through the vertical shaft pumps originally employed for ash handling. As a consequence, the large pieces remained in the sump until they built up to the point where operation could no longer be carried on.

Consideration was given the possible advantage of installing a horizontal shaft pump at floor level in order to eliminate the heavy maintenance costs of a vertical shaft pump. The final selection was an Amsco-Nagle Type "T" pump.

Naturally there was the priming problem, but the company's engineers were satisfied that this could be overcome by the use of the priming inductor. With this device no valves are necessary in either the suction or discharge pipe and priming is effected practically instantaneously. In order to make possible the passage of a larger percentage of the bigger material, a



larger pump was chosen. In view of the plant's high pump repairs cost it was decided to operate the new pump at considerably lower speed than the original pump. As floor space was limited and head room abundant it was gratifying to be able to supply a pump on which the motor could be mounted overhead. This characteristic of this type of pump has saved valuable floor space in a number of installations.

The 8 in. Amsco-Nagle Type "T" frame 24 pump was installed in November, 1944. This pump has in two years of operation proved, as had been anticipated, very satisfactory not only from a maintenance standpoint, but also through the elimination of some very nasty jobs in the ash handling work of the plant.

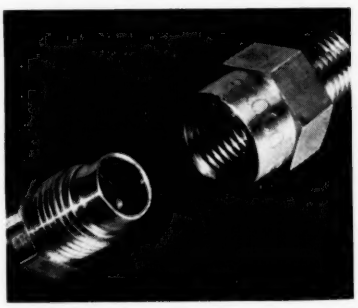
The pump was manufactured by the American Manganese Steel Division of American Brake Shoe Co.

H Self-Flaring Tube Fittings

Development of a revolutionary new two-piece, completely self-flaring tube fitting, which may be applied to many varieties of tubing, was announced this week by the Brockway Co.

The new fitting, known as the Uniflare, embodies all the advantages of both compression fittings and flared fittings, with none of the usual disadvantages of either. It may be used effectively with tubing of various metals, including copper, aluminum, monel, plastic, "Bundyweld" and other varieties of steel, within a wide range of wall thickness.

Plain end tubing is inserted in the fitting and made up in the conventional manner. The tube is self-extruded and self-flared by simple wrench action during the make-up. The fitting is so designed that the nut, body and thrust collar combine to produce the same smooth positive action as an extrusion press—the thrust collar



shearing from the nut when wrench pressure is applied.

In fact, every fitting is in reality a miniature machine. What actually happens is that the nut acts as the ram; the body of the fitting acts as the die; the thrust collar acts as the dummy block and compression member to grip the tube and force it into a precisely shaped 37 degree flare. The shape of the flare is important in making a sound joint. The extrusion and coining action of the parts produces a leakproof joint that is reinforced against pressure and vibration; that can be made up innumerable times without danger of damage to the original flared end of the tube and without losing its positive seal.

The action with soft tubing is readily understandable, but the ease with which these brass fittings handle steel tubing is nothing short of amazing. They are made in sizes from 1/8 in. to 3/4 in., in all the usual commercial shapes.

All piping equipment for every need ...on one order to CRANE

Yes, sir! . . . one order gets you everything for the job . . . good, dependable material down to the last item. But that's just one way the truly complete Crane line helps to simplify all your piping jobs.

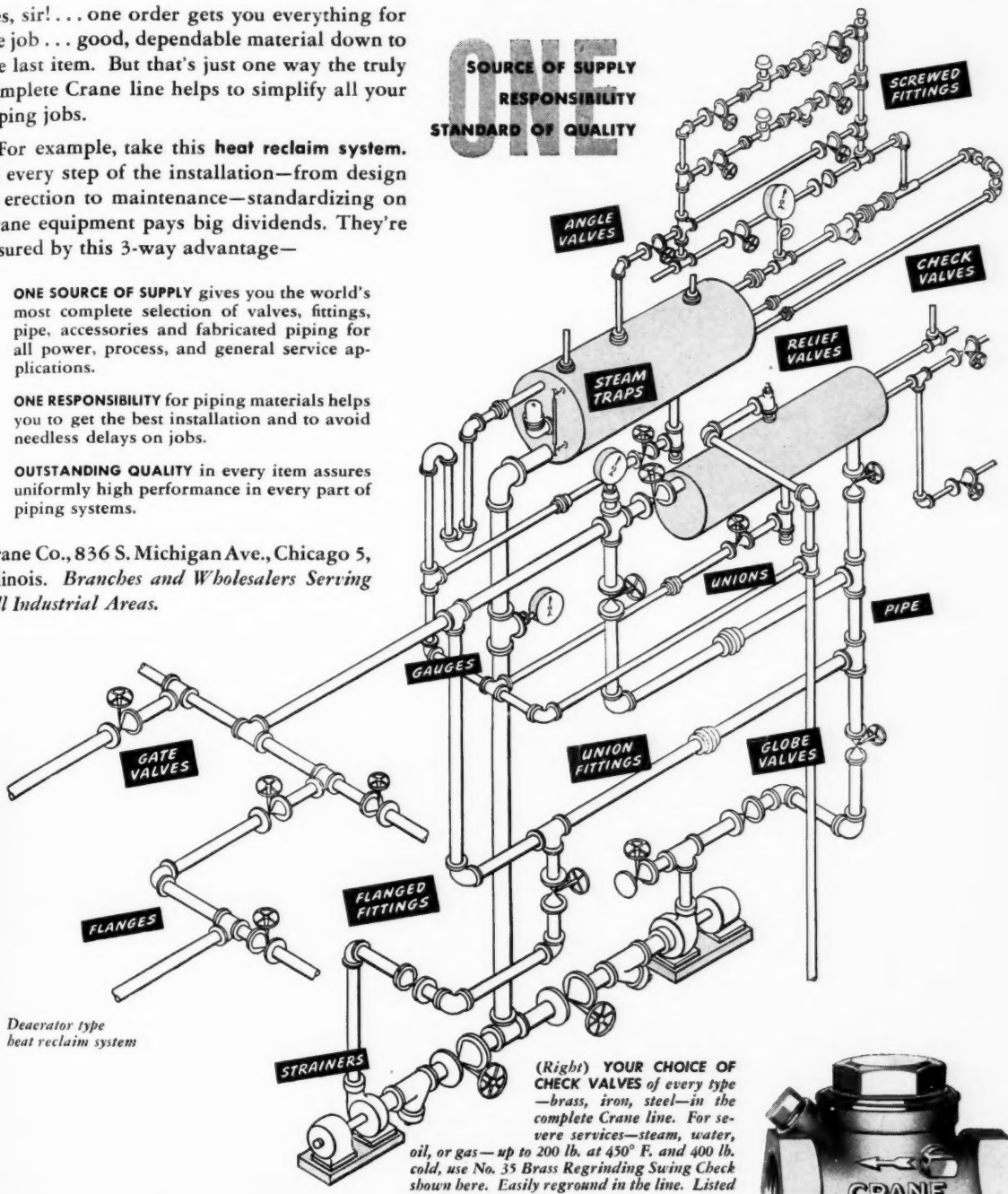
For example, take this **heat reclaim system.** At every step of the installation—from design to erection to maintenance—standardizing on Crane equipment pays big dividends. They're assured by this 3-way advantage—

ONE SOURCE OF SUPPLY gives you the world's most complete selection of valves, fittings, pipe, accessories and fabricated piping for all power, process, and general service applications.

ONE RESPONSIBILITY for piping materials helps you to get the best installation and to avoid needless delays on jobs.

OUTSTANDING QUALITY in every item assures uniformly high performance in every part of piping systems.

Crane Co., 836 S. Michigan Ave., Chicago 5, Illinois. *Branches and Wholesalers Serving All Industrial Areas.*



Deaerator type heat reclaim system

(*Right*) **YOUR CHOICE OF CHECK VALVES** *of every type —brass, iron, steel—in the complete Crane line. For severe services—steam, water, oil, or gas— up to 200 lb. at 450° F. and 400 lb. cold, use No. 35 Brass Regrinding Swing Check shown here. Easily reground in the line. Listed in your Crane Catalog, page 57.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

J Auger Bit Set A new auger bit set for fast, easy wood-boring is announced by Bruno Tools. The bit set consists of an 8¼ in. shank and a number of quick-change boring heads, packed in a rigid two-color plastic case. It comes in two sets. One set contains six boring head, ⅝ in to 1¼ in by eighths. The second set contains eleven boring

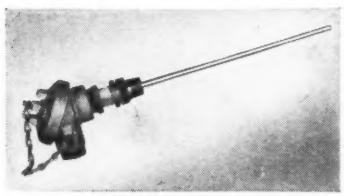
heads covering a range from ⅝ in to 1¼ in. by sixteenths. Both sets are available with straight shanks for use in bench drill, drill press or portable drill, or with square shanks for use in hand brace.

Now for the first time, the manufacturer states, it is possible to bore many different size holes with one auger bit by simply changing the boring heads. This saves time for the operator, as it is easier to change boring heads than to switch bits. The operator simply loosens the set screw and inserts the desired size quick-change boring head. The boring head locks securely with a positive-seal precision fit. Set screw merely acts as a safety lock.

Even in the hardest woods they require no forward pressure in boring and turns easily with only finger-tip pressure. This is made possible by the extra long cutting edge of the boring head and by the specially designed lead screw which actually pulls the tool through the wood. There are no flutes to bind or clog.

K Fast-Acting Thermohm A new type of industrial Thermohm (resistance thermometer bulb) now extends the range of Leeds & Northrup Co's. resistance thermometer recorders and controllers to temperatures as high as 1000 F.

This Thermohm is amply accurate for the more exacting industrial requirements. Speed of response is much faster than that



of usual heavy-gauge couples and is matched only by small pipe-type or fine wire couples. Rugged, durably constructed, this Thermohm is easy to install in ovens, tanks, ducts or pipe lines.

Its own corrosion-resisting stainless tube gives ample protection for normal pressures and non-corrosive fluids. Like any thermocouple or thermometer bulb, the Thermohm can be used with protecting wells where required. The temperature is thoroughly protected against contamination by moisture or gases.

Like the company's thermocouples and lower-resistance thermometers, the new Thermohm is equipped with the standard universal head that facilitates installation and connection. Standard lengths are six and twelve inches.

L Electronic Contactor For Resistance Welders For resistance welding jobs involving exceptionally high speed operation or heavy primary currents of short time duration, square D Co. offers a complete new line of electronic contactors using ignitron tubes. These electronic contactors are offered to supplement the Syncro-Break and High Speed magnetic contactors which are recommended where lower installed cost and economical operation are important factors and where welders must operate over a wide range of weld times and duty cycles.

Design of the new Class 8990 electronic contactors provides increased wiring space with power connections made near the center of the enclosure allowing minimum bending of power cables. The contactor is assembled on a removable steel base plate. All control elements are grouped at the righthand side away from tubes and cables

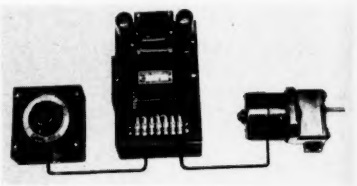
and out of the path of any dripping from water condensation on tubes and hoses.

Cabinets are heavy sheet steel with ventilating louvres in the door and drain holes in the bottom. Flat door construction is used to permit close ganging of contactors and provide maximum utilization of space.

M Morpholine Morpholine is a volatile compound that inhibits corrosion due to carbon dioxide in steam and condensate-return lines of steam heating or processing systems. It is once again freely available after several years' shortage during the war. It is suggested for the treatment of feedwater for boilers supplying low- or medium-pressure steam to heating or processing systems with extensive piping or condensing surfaces.

Carbon dioxide dissolved in condensate water is one of the primary causes of corrosion in steam and condensate-return lines. Morpholine is an alkali which controls acidity due to free carbon dioxide in the feedwater or carbon idoxide resulting from decomposition of soluble carbonates. Morpholine evaporates with water in definite proportions, so that any desired alkaline value in the steam generated can be maintained by adjusting the concentration in the boiler. Only small amounts of the chemical are required to inhibit corrosion effectively. As a corrosion inhibitor, morpholine appears suitable for use in steam power plants, laundries, greenhouse heating unit, and apartment house and hotel heating systems. Carbide and Carbon Chemicals Corp.

N Remote Motor Control This packaged remote control, called "Synchro-Link," is a positioning servo control designed to quickly and accurately position a distant motor according to the setting of a control trans-



mitter. It is announced by Yardeny Laboratories, Inc.

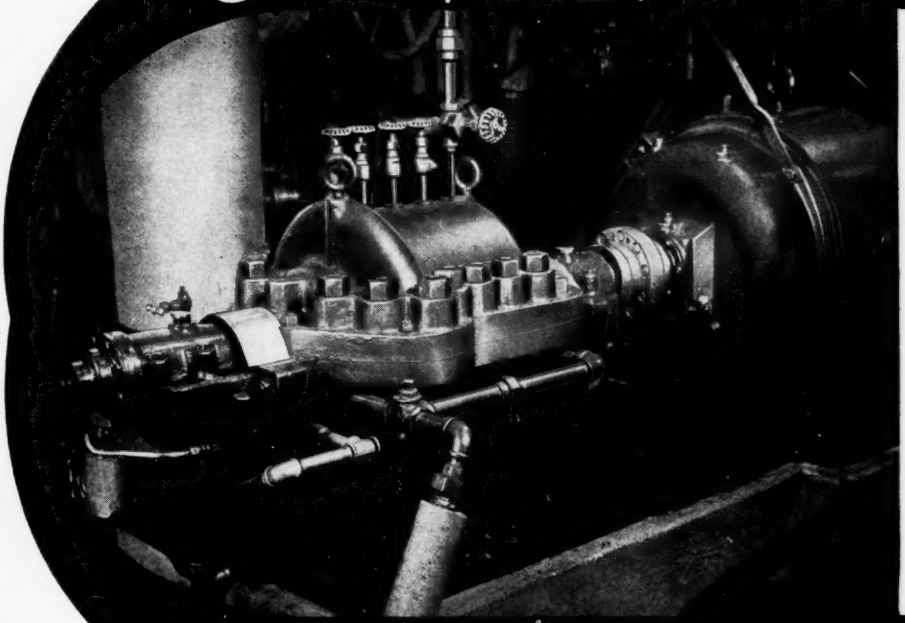
All that is necessary is to set the dial at the left in the illustration and the Synchro-Link, center of illustration, tells the motor which way to turn, when to slow down and where to stop. The unit works on the principle of a self-balancing electronic bridge. It consists of three basic elements: 1. The master control with a knob and a calibrated dial for manual control or with ¼ in. shaft extension for automatic control. 2. The Synchro-Link electronic controller. 3. The load control potentiometer geared to the motor or coupled to the load. All elements are described as standardized and interchangeable.

O Recorder Chart Bailey Meter Co. has recently introduced recorder charts printed in neutral gray. This makes it easier for operators and supervising engineers to read the charts because of the greater emphasis given the various colored records by the neutral background. The new charts are especially valuable on recorders installed where lighting is poor or where it is impossible to get a clear view of the chart. The improvement in legibility is especially apparent with the dark colored recorder ink normally used, such as red, blue and green.

Bailey charts are accurately made from wax engraved plates insuring perfect, correctly spaced, concentric divisions. The center holes are punched simultaneously with the printing to insure accurate centering. A special trimming process provides full size charts while eliminating errors caused by eccentric charts. The use of a high grade paper minimizes shrinkage and blotting.

P Packless Diaphragm Control Valves The Hammel-Dahl Co. has eliminated stuffing boxes in the 3000 B Series of packless diaphragm control valves Over three years of continuous operation under varied and severe operating conditions without any failures indicates basically correct design. The use of packless bellows sealed con-

Hardly a sign of wear...



Can you match this record?

This relatively small boiler feed pump, delivering 250 gpm against 513 psi, required no replacement parts or reconditioning after 45,000 hours of service.

...after 45,000 hours of service

THE EXCELLENCE OF DE LAVAL design and construction is demonstrated by the performance of a De Laval boiler feed pump recently inspected after 45,000 hours of service in the municipal power plant of the City of Wyandotte, Michigan.

The following paragraph is quoted from the inspector's report:

"All machined surfaces of the case are in original condition. Diaphragms and balance arrangement fit neatly in all bores. Horizontal joint has no indication of leakage. Faces of rotating and stationary balance plates are in good condition; wear is approximately .005". Shaft sleeves are highly polished but are not worn or grooved. There is no leakage between shaft sleeve spacers and wheels. The shaft has no indication of contact with water. Wheel wearing rings show no indication of wear. No new parts were used in reassembling."

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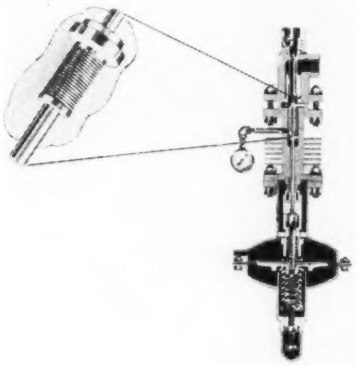
TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

struction, assures a leakproof control valve and definitely simplifies the control of many difficult and dangerous processes. The packless design can be applied to any size or type Hammel-Dahl Flo-tested Control Valve for a working pressure of 500 psi at any temperature between minus 70 F to plus 750 F.

Bellows sealed construction should be used for handling toxic or dangerous fluids, which would be dangerous to personnel



or property if leakage occurred. Packless construction is desirable for high vapor pressure fluids and on vacuum applications. It is a definite must where extremely valuable fluids are being handled. It should be used for handling refrigerants and all fluids which solidify on coming in contact with the air. Packless valves should be used wherever stuffing gland leakage cannot be tolerated.

The bellows unit can be easily inspected or replaced in the field. Damage to the bellows from torsional twisting in assembly or disassembly of the valve plug and stem is prevented by a hexagonal stem passing through the mounting ring. This design prevents any damage to the bellows unit even when the unit is taken apart by completely inexperienced personnel.

The bellows unit is available in two-ply Type 347 Stainless Steel as standard. It may be mounted on any size screw end valve from ½ in. to 1½ in. and flanged end valve from 1¼ in. to 12 in. Whole valve lift is assured in all sizes.

Q Flexible Hose Welding A new method of directly welding flexible hose to a fitting—sought by the metallic hose industry for many years—has been developed by the Pennsylvania Flexible Metallic Tubing Co.

By this new process, a pressure-tight, leak-proof assembly can be made by welding hose directly to a fitting—flange, sleeve, etc.—without the use of heavy and expensive couplings. The new weld is shown to be leak-proof and pressure-tight by hydrostatic test.

R Combustion Supervisor Unit A combustion supervisor of improved design and construction has been announced by Worner Electronic Devices. Incorporating latest design features, the unit dependably maintains correct combustion conditions in all boiler operations, assuring continuous maximum efficiency with lowest fuel consumption.

Operating on the smoke detection principle, the system consists essentially of a light source projecting a beam of light across the boiler breeching to a receiver containing a sensitive photo-cell. When the density of smoke passing through the breeching exceeds a pre-determined level the beam is broken and the system actuated, thereby instantly averting loss of efficiency and needless increase in fuel consumption. A valuable aid also for complying with smoke ordinances.

To avoid unnecessary operation of control equipment from voltage drops or from excess smoke density of momentary duration, a variable time-delay may be adjusted to control operation for any interval from instant to one-half minute.

Smoke density is shown at all times by the meter and illuminated colored jewels on the Control Cabinet. Should a permanent and continuous record of boiler behavior be desired, a recording meter is available as an auxiliary accessory.

S Soldering Flux in Stick Form Handy as a pencil, greater convenience in use, elimination of messy containers and brush and stick applicators, greater efficiency, a big time and money saver—there are the features of the new Flux-Stik, a specially designed and chemically advanced soldering flux molded into clean, always ready, easy-to-use stick form. It eliminates waste, permitting just enough flux for the joints.

It is described as non-acid, yet it thoroughly and quickly dissolves the oxides of metals and thus prepares a free, clean and better surface for the solder to alloy itself firmly with the metal. With it no cleaning of the metal is necessary.

It is non-running. When heat is applied, the flux will just cover the immediate vicinity of the soldering joint. It will not spread itself all over the surface of the metal, thus keeping it clean and free both from wasted fluxing material and solder.

This flux can be applied equally well either to hot or cold metal. It permits the solder to flow easily and smoothly and to adhere firmly and thoroughly to the metal. It insures perfect joints, thus eliminating costly repairs and the frequent necessity with older type fluxes of having to repeat the soldering process when joints do not hold.

It is said to be ideal for overhead, inaccessible and out-of-the-way soldering locations where cleaning of the metal is clumsy and inconvenient. It can be used for sweat joints of copper or brass tubing, manifolds, traps, elbows, piping, sheet metal, cabinet work, refrigeration and heating coils, etc. It is made by Lake Chemical Co.

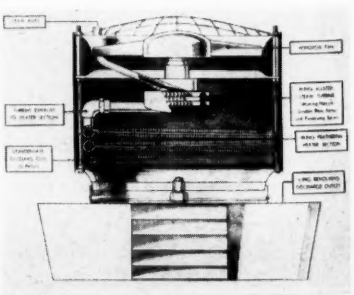
T Adjustable Work Stands Aerostands, the hydraulically operated adjustable work stands, long famous in aviation wartime applications in bases all over the world are now

available in quantity for general industrial use, according to Airquipment Co.

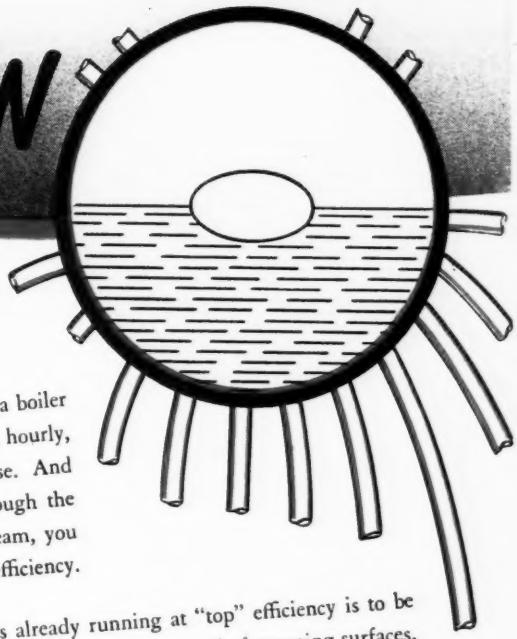
A 16 sq ft work platform, with a maximum static load capacity of 1500 lb, is hydraulically elevated or lowered to any working level from 3 to 24 ft according to the individual model. The units feature the use of automatic and self-adjusting steps which maintain their position parallel to the ground regardless of the working angle of the stand.

Scaffolding strips, stand extensions and hoist attachments further enhance the general utility features of the Aerostands. All models are equipped with guard rails and skid proof surfaces on platforms and steps. Frames are constructed of welded tubular steel mounted on swivel casters with caster locks. Truck locks are provided to hold stands stationary when in service. Tow bars, scaffold strips, stand extensions and hoist attachments are optional equipment.

U Source of Heat Operates Fan A welcome development in view of the electric motor situation is the introduction of the Wing



LINE OF ACTION



FOR GREATER ON-THE-LINE PRODUCTION

When you lengthen the in-service time of a boiler generating many thousands of pounds of steam hourly, you realize a substantial production increase. And when you transmit without needless loss through the metal to the water the heat to make that steam, you approach still nearer to maximum operating efficiency.

Such improved performance from boilers already running at "top" efficiency is to be expected when you charge APEXIOR NUMBER 1 with direct control of steaming surfaces, for APEXIOR adds to water-exposed metal a resistance and endurance not to be found in the best of boiler steel — gives it a surface that's insoluble in natural, evaporated or chemically treated water.

Applied to drums by hand brush and to tubes by Dampney-supplied power coater, APEXIOR NUMBER 1 fills, seals and smooths the surface structure of new or newly cleaned metal, discouraging deposit accumulation and preventing scale-to-metal bonding.

- *That's why an APEXIORized boiler stays on the line longer between inspection and cleaning outages, delivering at highest efficiency from start of run to finish —*
- *why its surfaces remain insulation-free, for better heat transfer —*
- *why it goes back into service faster, at less cost in man-hours of cleaning time.*

Let us tell you how APEXIOR NUMBER 1 can help you better your own best record. Write for Industrial Bulletin to The Dampney Company of America, 1236 River Street, Hyde Park, Boston 36, Massachusetts.

Ask for information also on APEXIOR NUMBER 3, for cold-water-exposed metal, and THUR-MA-LOX High Heat Resistant Coatings, effective to 1600° F.

APEXIOR REG. U.S. PAT. OFF.

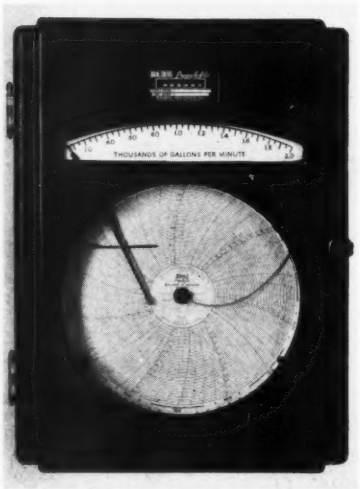
THE DAMPNEY COMPANY OF AMERICA
HYDE PARK, BOSTON 36, MASSACHUSETTS
THURMALOX DIVISION, BOYLESTOWN, PENNSYLVANIA

3-46-1

Turbine Revolving Unit Heater by L. J. Wing Mfg. Co. In this, the fan is driven by a remarkably compact all-steel steam turbine. The turbine exhaust passes into the heater section where it is used to heat the air which the turbine-driven fan then delivers through the revolving discharge outlets to the working level below. Condensate, which is never at a higher temperature than 170 F is returned to the boiler through an open return system. The advantages claimed are elimination of electric motor and electric power, no back pressure, no packing, no traps.

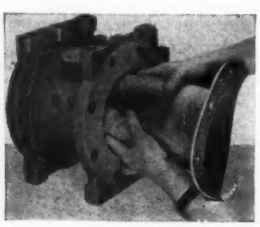
V Totalizer Indicator Recorder An electrically operated secondary instrument for use with Propeloflow, Shuntflo or other mechanical flow meter, or as a recording-indicating-totalizing tachometer, has recently been announced by Builders-Providence, Inc.

The instrument is actuated by impulses



over a two-wire circuit from a transmitter which is mechanically driven by a primary meter. No power supply is necessary for the primary instrument. The transmitter consists of a switch which makes a contact for a predetermined number of gallons as they pass through the meter. The new instrument provides readings of total flow, rate of flow and a chart record of flow over any distance from a few feet to many miles from the primary instrument. Mounted in a rectangular case, the new instrument conforms in size and appearance with other Builders instruments and can be attractively mounted with them on central control boards.

W Butterfly Valve This recently announced positive shut-off butterfly valve is reported to attain 100 per

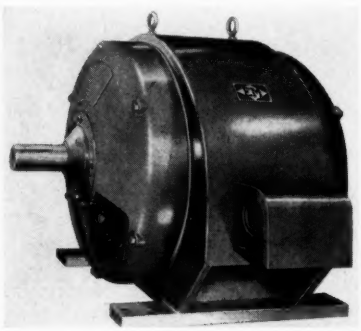


cent shut-off by virtue of the wedge-type action of the butterfly vane within a renewable, replaceable rubber seat. This rubber spool, shown being removed, in the illustration, offers a pliant cushion to this wedge-like closure of the vane. Replacement of the rubber spool is said to be simple. It is folded up, slipped through the valve body and then smoothed out over the flanges. The valve is available in heavy duty and Standard flanges. Temperature range is from minus 20 F to plus 200 F. R-S Products Corp.

X Resin Bonded Diamond Wheels A new addition to its line of abrasive wheels announced by Manhattan Rubber Division, Raybestos-Manhattan, Inc., are resin bonded diamond wheels for grinding carbides and carbide tipped tools.

An exclusive feature claimed for diamond wheels is the special resin bond which has been developed not to load or glaze when coming in contact with soft or hardened tool steel shanks of carbide tipped tools. The economy of this feature according to the manufacturer is realized in full wheel life through the elimination of the dressing or lapping usually necessary on other wheels in order to clean the bond. They are said to be faster and cooler cutting on carbides. A complete line of wheel types and shapes is available in grit sizes from 60 to 400.

Y Heavy-Duty Induction Motors Newly available "Heavy Duty" squirrel cage induction motors for large-power drives from 100 to 1000 hp, 1800 rpm and lower speeds,



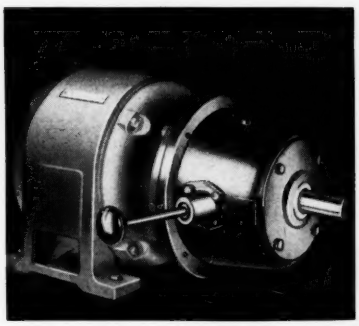
answer industry's demand for motors designed for drip- and splash-proof construction.

Fabricated steel frame shuts out falling particles, makes operation quieter, invites easy cleaning. Inspection and blowing out is simplified on larger ratings with access plates designed for speedy removal, replacement. Sealed bearings can be cleaned and refilled without motor disassembly. Double end ventilation is provided by a blower on each end of the rotor. Starting characteristics are NEMA Class B (normal torque, low starting current), for across-the-line starting. Is announced by Electric Machinery Mfg. Co.

Z New Sheave Lines Two new lines of QD sheaves, featuring improved groove-belt fit and reinforced arm construction, have been announced by Worthington Pump and Machinery Corp. Designated as the A and B lines, each will feature individual groove size to match belt size—thus an A groove for an A belt, a B groove for a B belt. Former A-B combinations have been discontinued.

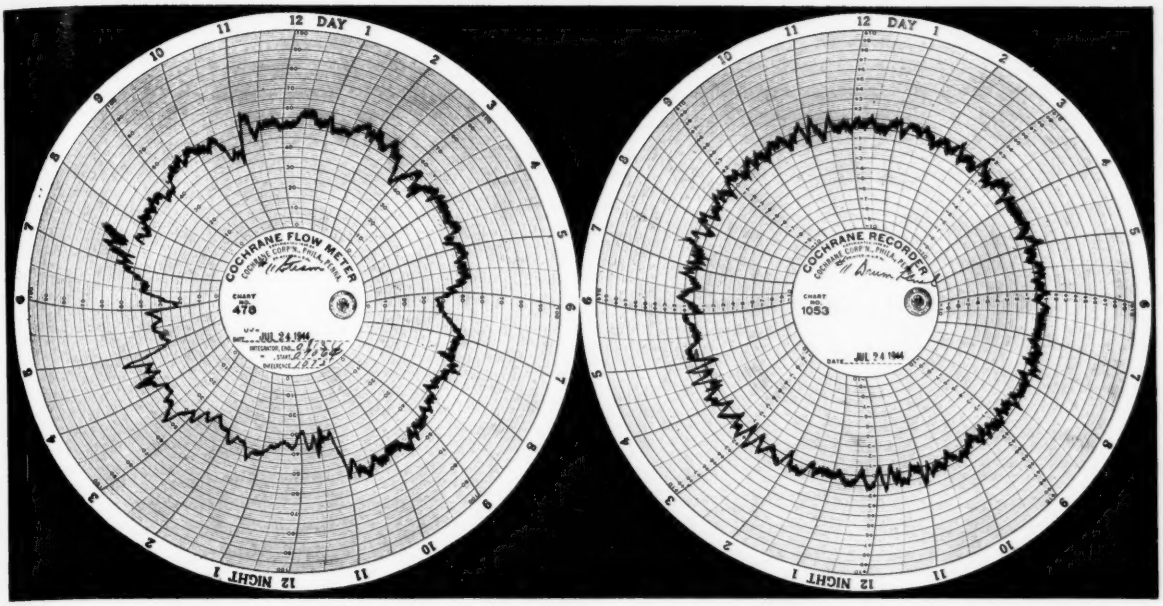
Like the "I" beam construction of a bridge girder the reinforced arm construction of the new Worthington QD driven sheave incorporates a longitudinally ribbed arm recessed down the middle. Advantage of this type of arm is that material is removed at or near the neutral axis where it adds little or no strength to the arm. This material is then added at the points most remote from the neutral axis where it gives the greatest strength.

AA Motor Transmission A two-speed motor transmission—a unit that may be used to replace two-speed motors, with the added advantage of providing special ratios not obtainable with standard two-speed motors, is announced by the Western Manufacturing Co. Direct motor speed, neutral point, and any desired reduction up to 6.25 to 1 are obtained



through an automotive-type gear shift lever. Standard reductions are 1½ to 1; 2 to 1; 3 to 1; 4 to 1.

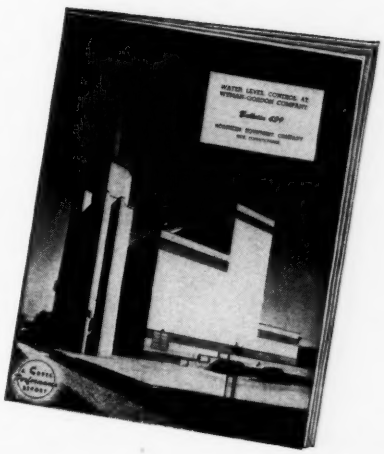
Units manufactured to apply on motor frames, Nos. 224, 225 and 254 are mounted upon flanged-type end shield and can be swiveled about on the face of the flange so that the shifting lever may be in any one of three different positions, 90 degrees apart, (either one of two horizontal and one vertical (upright) position). In the larger sizes these new two-speed transmissions are made with modified base mounting, corresponding with legs of motor frame. Four to six week delivery can be given on standard models.



FORGING HAMMERS *Swing Steam* DEMAND 5,000 POUNDS PER HOUR INSTANTANEOUSLY

BOILERS carrying forging loads offer one of the more difficult problems of water level control. Their constant load fluctuations, caused by varying steam demands from hammers and presses, result in abnormal "shrink" and "swell" of fluid within the boiler drum. But COPES Flowmatic Control assures safe, dependable stabilization of the boiler water level, no matter how rapid or wide the load swings.

At Ingalls-Shepard Division of Wyman-Gordon Company, Harvey, Illinois, COPES Flowmatic stabilizes water level within plus-or-minus 1½ inches, despite almost instantaneous load swings of 5,000 pounds per hour. That's why all eleven boilers are equipped with COPES Flowmatic. Write for Bulletin 459—Water Level Control on Drop Forge Loads at Wyman-Gordon Company—a performance report.



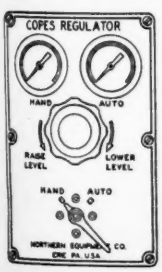
NORTHERN EQUIPMENT COMPANY
372 GROVE DRIVE, ERIE, PENNSYLVANIA

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS: Canada, England, France • *Representatives Everywhere*

★ GET CLOSER LEVEL CONTROL WITH COPES FLOWMATIC

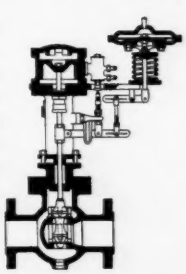
AIR-OPERATED REMOTE CONTROL



Permits absolute flexibility of installation for COPES Feed Water Regulators of either simple-level-control or two-element Flowmatic type. COPES transfer switch and control panel illustrated provides remote positioning of feed valve from boiler operating board or any other desired point. Air is used as the operating medium. Dependable performance is demonstrated daily in many COPES-equipped high-duty steam-generating stations.

PRESSURE REDUCING VALVES

Ideal for those applications where results not attainable with "stock" valves are desired. There are eight types, direct-and relay-operated, from which COPES engineers select the one best suited to demands of the individual installation, then design ports and pressure range for the specified conditions. Low friction, accurate balance and ample power. Available as single units or for multiple installations. COPES Master Control permits remote operation.



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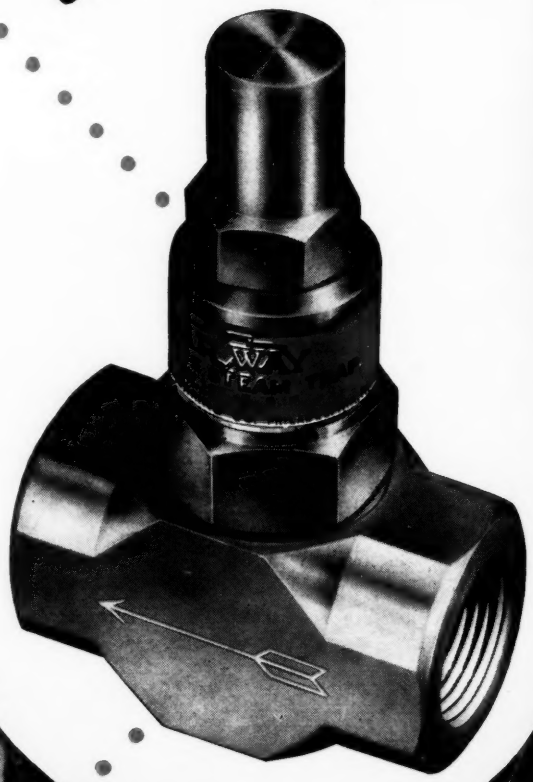

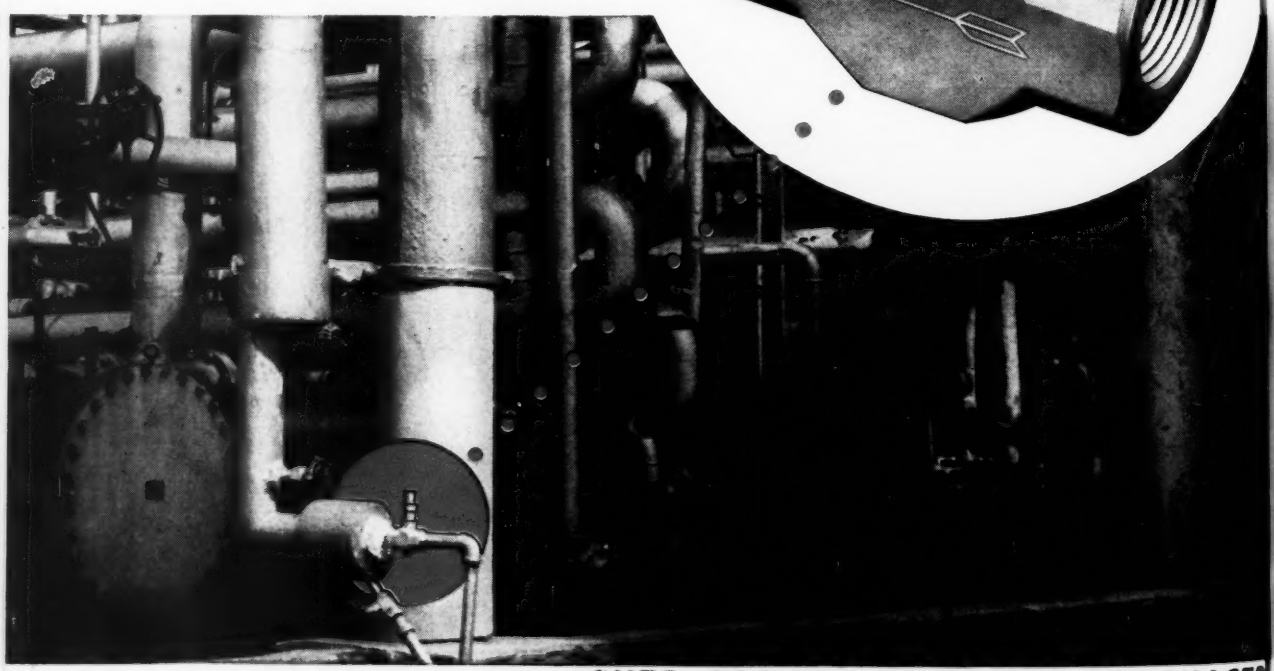

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WHAT LEADERS SAY

Today's Men and Yesterday's Machines

By JOSEPH L. TRECKER

WHAT WOULD happen if, instead of talking about the economic justification for investment in plant assets, I would introduce this discussion here today by talking about the *social* justification for investment in plant assets? Let's try it and see what happens.

By and large, therefore, throughout business, those who contrive to give more people better things at lower cost, survive; and those who fail to do so are eliminated. The net result is a continuing increase in the standard of living.

So, from a social standpoint, you might say that industrial profits are *the reward which is earned in return for raising the standard of living of the people.*

Companies who do not realize that this is the price to be paid for survival do not last long. Companies that *do* survive are always and forever engaged in this perpetual job of trying to offer the consumer more value per dollar.

Now—we are inclined to say that this job is accomplished primarily through utilizing every possible way to cut costs. I think that is the wrong way to say it. The fact is that it is accomplished by *increasing output per man per hour.* When men multiply their output, supply increases, and prices go down. And the key to increased productivity is the machine.

We have got to remember that during the war we suspended, to a large degree, the principle of competition. We based our prices upon costs, and we figured our costs on the basis of existing equipment. Some of us fell into the delusion of assuming that we could go right on basing our prices upon costs as they stood at the moment.

When the war was over, that delusion still persisted because of the shortages accumulated during the war. In fact, for people who so loudly proclaim allegiance to the competitive system, some of us acted very peculiarly indeed. Instead of trying to increase output per man in our plants and thereby cut our costs, we let our costs stay right where they were and then ran down to Washington asking for an increase in prices.

Now that the OPA restrictions have been suspended on all manufactured goods, there is a great deal of danger that a good many people will go right on thinking, for a while at least, that they can pass the costs of inefficiency on to the customer because of a relatively high demand for goods in short supply.

From a social standpoint, do you realize where that sort of behavior would lead us eventually? If manufacturers think they can always base their prices upon their present costs, what's to prevent costs from continuing to go up? What's to prevent output per man from continuing to decline? The social significance of that road is terrible to think of. That is the path to a declining standard of living—*and we had better watch our step in this country to make sure we are not on it.*

Right now we have a wage-price spiral in this country that is appalling. How long do you think we can keep the capitalist system, if the margin between wages and prices grows smaller instead of larger? The fact is that not only the survival of individual companies, but the survival of the whole competitive system, is dependent upon industry's ability to reverse the inflation spiral and to get back to its basic job of providing better things for more people at lower cost.

And that means the purchase of new and improved production equipment.

The men who hold the purse strings know this full well; but many of them hesitate to make large-scale commitments. They say "Conditions are unsettled. We don't know what government is going to do. We don't know what labor is going to do. We don't know what the stock market is going to do. We don't know what's going to happen to the international situation." All that is very true. But, gentlemen, we do know that water runs downhill—and we know with equal certainty that the installation of better equipment is the key to long-term survival.

If we are going to wait, in this country, until conditions are settled, we may have a long time indeed to wait; and by that time it may be too late.

Some manufacturers hesitate to install new and better machine tools because under present conditions they have great difficulty in getting out of these new and improved machine tools the increased productivity which has been built into them.

During the war, organized labor, encouraged by government, began developing the philosophy of limited productivity. I haven't time here to go into the reasons, but, briefly speaking, they were founded, I believe, upon organized labor's desire for what they call "union security," and upon the worker's mistaken idea that limited output was conducive to job security. Of course there never was a more fallacious idea spread at large among the American public.

There is a tremendous job of education to be done along this line. Somehow, we must convince the employees in our plants that maximum productivity is the only sure road toward

(*Continued on page 136*)

Joseph L. Trecker, executive vice-president of Kearney & Trecker Corp., was born in Milwaukee, Wis. in 1902. Upon completing his college training at Iowa State College in 1924 he joined Kearney & Trecker in the Engineering Department. Successively, he became a director of the company in 1928, vice-president in 1936, and has been executive vice-president and director since 1942.

He is also President of the Amtea Corp., an organization of machine tool companies serving the Latin and South American countries. Early in the U. S. defense program he served as consultant to the Secretary of War; during 1941 organized and became chief of the Sub-Contract Branch of the OPM; later served as Deputy Director of the Contract Distribution Division of that agency. He was a member of the National Tool Industry Advisory Committee of the WPB. He was a director of the National Machine Tool Builders Association from 1942 to 1945 and its president from 1944-1945.

During the past two years, Mr. Trecker has spoken and written on the principle that production is the key to high wages, lower prices, and full employment for America. Several of his articles are now available in booklet form. The material presented here is from his address last November before the Production Conference of The American Management Association.

The Tidd Plant Of The Ohio Power Company

By **S. N. FIALA,** Mechanical Engineer, American Gas & Electric Co.

and **EDWIN H. KRIEG,** Consulting Mechanical Engineer, American Gas & Electric Co.

THE PLANT named after Geo. N. Tidd, President of the Company and a pioneer in power system development, is the latest addition to the great regional power tool that is the Central System of the American Gas and Electric Co. Interconnected by a 132,000-v transmission network, this system of 1,750,000-kw capacity shown in Fig. 1 serves portions of Virginia, West Virginia, Tennessee, Kentucky, Ohio, Indiana and Michigan. This system is supplied by the following major steam-electric stations:

Cabin Creek, Glen Lyn, Kenova, Logan—(of the Appalachian Electric Power Co.)

Tidd, Philo, Windsor—(of The Ohio Power Co.)

Twin Branch—(of the Indiana & Michigan Electric Co.)

Hazard—(of the Kentucky and West Virginia Power Co., Inc.)

When the decision to proceed with the Tidd installation was made, the Central System peak had grown to about 1,200,000 kw, which made a unit of approximately 100,000 kw size a sound selection from both a system operating and an economic point of view. Therefore, an 85,000 kw nominal, 95,000 kw capability, cross-compound unit had been ordered. Six such units had already been placed in service or were on order for Philo, Cabin Creek, Twin Branch and Glen Lyn. However, after the order was placed, the War Production Board required that this unit and that for Glen Lyn be changed to a single-cylinder, single-flow design in order to: (1) save use of large machine tools and space in turbine manufacturer's shop, (2) save critical materials, as the original cross-compound unit weighed more. This change affected adversely plant performance by some 200 Btu per net kwh.

To help improve plant performance, a search of ideas focussed attention on reliability, and this became one of the important objectives. Painstaking attention was therefore given to the design and arrangement of equipment to secure reliability, and examples of this approach are described later.

The first installation consists of a 100,000 kw, single-cylinder, single-flow turbine and two 475,000 lb/hr steam-generating units operating at 1300-psig pressure and 925 F, the highest that has been employed in a turbine of this type. It went into operation September 28, 1945.

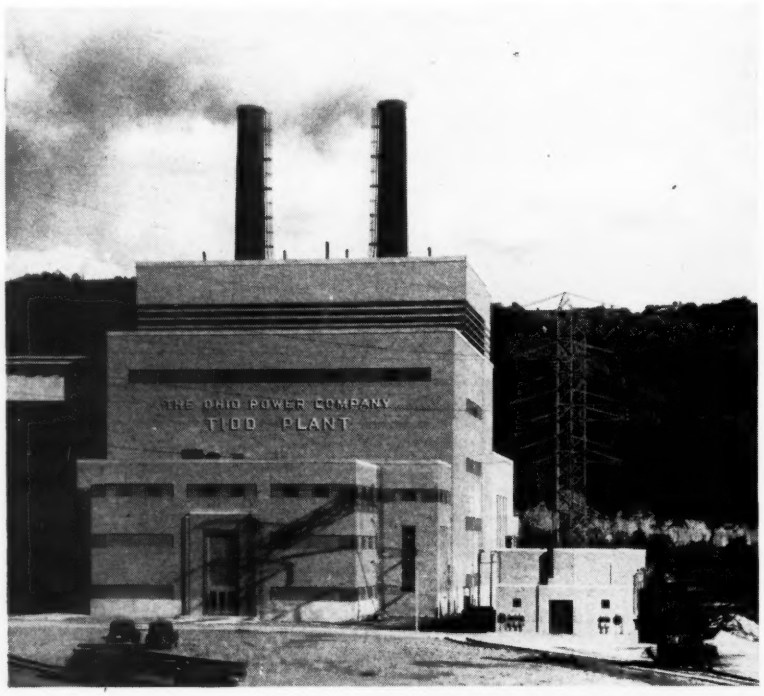
The plant is located on the Ohio River about ten miles south of Steubenville. The general arrangement of the buildings, coal storage and substation is shown by Fig. 2.

Plant Cycle Has "Built-In" Reliability

Figure 3 shows the cycle adopted for the Tidd Plant. This was developed to afford optimum financial return. This includes not merely economy of fuel but also reliability, for fuel economy means nothing to a plant that is shut down. The means used to cool the main generator affords a good example of the effort to incorporate high reliability in the cycle.

After leaving the condenser, a portion of the condensate is passed through the generator hydrogen coolers. This was done chiefly to minimize the amount of cleaning needed by the hydrogen coolers as the Ohio River is extremely turbid after heavy rains. In addition, leaves, twigs, and other trash that combine with silt to plug tubes and small openings, emphasized the desirability of avoiding river water for cooling equipment where plugged tubes and loss of water might occasion a plant shutdown. River water may be used in equipment that may easily be taken out of service for cleaning but this could not readily be done without losing capacity with the particular type of hydrogen coolers available for this generator.

Because condensate temperatures are too high during the summer to cool the hydrogen sufficiently, a condensate cooler is provided. However, even after passing through the hydrogen coolers it is still cooler than the main condensate stream. Therefore, the cool condensate is sent to the suction of the hydrogen cooler pump to pass again through the hydrogen cooler—condensate cooler—pump cycle again. The cool condensate in this cycle "floats" on



A description of the principal features of the 100,000-kw, 1300-psi, 925 F turbine and plant cycle . . . Place of Tidd plant in American Gas and Electric Co. system . . . Design of plant features economy of fuel and reliability of operation . . . Condensate cooler used in connection with hydrogen cooler . . . Deaeration in condenser supplemented by positive pressure deaerator . . . Turbine design protects against sudden temperature changes, excessive starting speeds, oil systems failure, damage from blade deposits, failure of steam and water seals, and loss of vacuum . . . Centralized control provided . . . Structures provided to cope with floods

the main condensate stream but does not mix with it. Thus, not only is the object of reliability attained, but also fuel economy, as the main condensate stream is not cooled by the condensate in this sub-cycle.

Two stages of bleed heating are used before the deaerator. In addition, the installation of both a gland steam leak-off condenser and an evaporator condenser was found to be economically justifiable.

Although the condenser was especially designed for complete deaeration therein, here again the objective of economy through reliability made desirable the installation of a deaerator under positive pressure to insure complete deaeration. Subsequent tests have often shown some degree of air infiltration between the condenser and the deaerator. The source of such air inleakage is difficult to track down completely. Without a deaerator, these factors would have adversely affected plant reliability.

The heat rate shown on the diagram, Fig. 3, is 10,840 Btu per net kwh at a net plant output of 97,300-kw. (gross generation 103,800-kw). This is believed to give the best heat rate for a single-cylinder turbine without reheat with a boiler efficiency of 87.5 per cent.

Turbine and Its Features

The new 100,000-kw unit is substantially of the same capacity as six other units installed on the Central System during the last few years; thus requirements for system reserve, cold, hot or spinning, are not disturbed.

Figure 4 shows the General Electric turbine-generator which is an 1800-rpm, single-cylinder type. Throttle steam conditions are 1300-psi at 925 F, which is the highest temperature single-casing turbine built so far by the General Electric Co., the previous limit having been 900 F. The only other turbine of this type built for such a temperature is a sister unit at the Glen Lyn Plant of the Appalachian Electric Power Co. on the same system.

Among the features of this unit which provide reliability and safety are:

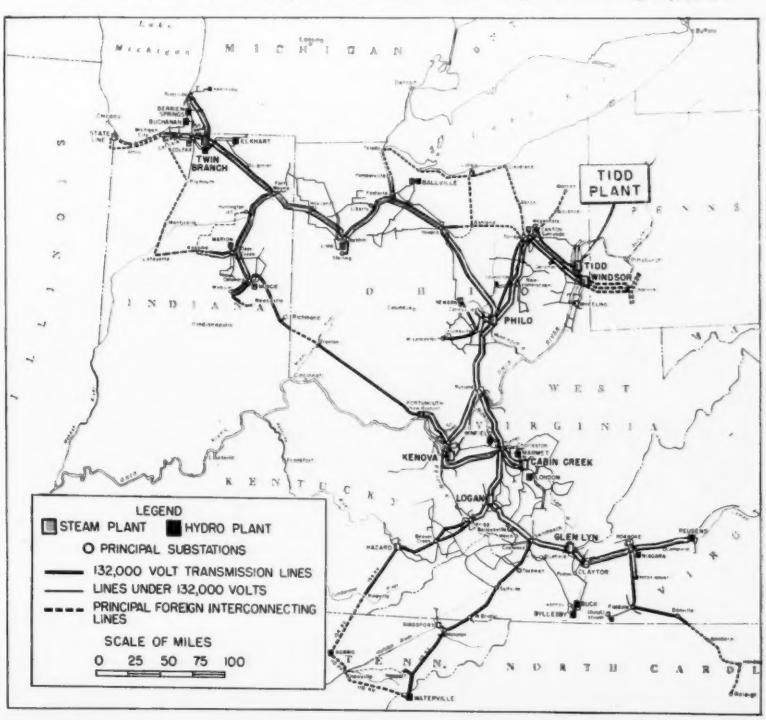
1. Protection against sudden temperature changes is afforded by an initial pressure regulator which closes the turbine control valves in case of a sudden drop in steam pressure. By thus maintaining the throttle pressure, the boiler is protected against too sudden loss of pressure, and the turbine is not subjected to damage by slugs of boiler water that might result from the "swell" occasioned by sudden pressure drop, as well as the accompanying thermal shock from sudden temperature change.

2. Protection against excessive starting speeds. The main operating governor has a motor-operated synchronizing device for controlling the speed from the switchboard while synchronizing or running; also a motor-operated handwheel for starting control. An innovation is the two-speed motor for normal speed opening but which permits fast closing. The reason for this special arrangement is:

The amount of steam "to break the turbine free" when starting up, is considerably more than needed to keep it rolling at low speed. Thus, after "breaking loose," the turbine accelerates too rapidly and somewhat excessive speeds are often reached with normal speed motors. The new motor permits closing the starting handwheel rapidly to prevent higher speeds than desirable during the starting operation. It can also close at normal speed. The ⅛ hp motor has a solenoid brake to minimize coasting and to position accurately the handwheel from the remote-control board when starting and bringing the turbine to speed.

3. Lubricating and control oil system reliability. Turbine reliability has been somewhat lowered by past difficulties with turbines which have an oil tank on the basement floor about 25 ft below. Trouble sometimes occurred with misalignment of the long shaft from which the gear-type oil pumps in the oil tank were driven from the driving gears on the main turbine shaft. This and other difficulties prompted the development of an independently-driven oil supply sys-

Fig. 1. The central system supplies seven states and has a peak load of 1,500,000 kw



tem. The Tidd unit is one of the first turbines to have its bearing and control oil supply entirely separated from the turbine shaft. Normally, two motor-driven oil pump sets are operated, although one would be sufficient. Each set has a lubricating oil pump and control oil pump on a single shaft. The two motors are supplied from two different station auxiliary buses.

If both auxiliary buses or both pumps should be lost, causing oil pressure to drop, the turbine-driven pump is started automatically. This turbine has two regulating valves; the first is arranged to start the pump automatically when the pressure in the control oil system drops a predetermined amount, and will stop the pump when the pressure is restored. The second regulator is provided for emergency in case the first fails to operate, and is arranged to unlatch if the bearing oil pressure drops to 15 psi. Once unlatched, it must be re-latched manually or the pump will continue to run even though the main motor-driven pumps are again started. Should the turbine-driven pump also fail, the turbine-generator would of course trip out from low oil pressure. In such event, an oil pump that is driven by an a-c and a d-c motor would start automatically. The d-c motor is supplied from the plant storage battery. Normally, the a-c motor operates but if the a-c is lost, the d-c motor comes in automatically. This smaller oil pump, which normally serves the unit while on turning gear and operates on a-c, has sufficient capacity to prevent bearing damage while the turbine is coming to rest. Control switches for the motor-driven oil pumps as well as the associated pressure gages are located in the control room. Special provisions exist to preclude oil leakage hazards. Turbine reliability has thus been greatly improved.

4. Safety in the event of turbine deposits. Practically all recent high-pressure, high-temperature turbines have had more or less difficulty with turbine deposits, usually during the first year of operation before treatment of feedwater has become a stabilized and routine matter. One difficulty was to determine whether or not a turbine was safe to operate at full load when it was known that deposits were between certain groups of stages or bleed points. There was no knowledge whether or not the deposits were evenly distributed among all stages as pressure gages were installed only at bleed points. If the deposits were uniform, no particular diaphragm would be overloaded and the loading of each diaphragm could be determined. But such uniformity cannot be assumed; the deposits may be chiefly on one or two diaphragms out of a group of five or six which cause overloading. To help determine whether or not the turbine would be safe to operate with turbine deposits, recording pressure gage connections were made on eleven of fourteen stages, making it possible to estimate accurately the loading of each diaphragm. The gages are grouped on a panel to facilitate comparison of trends in deposit build-up. It is expected that the proposed study of pressures at each stage will add greatly to the store of knowledge of turbine blade deposits. The location and extent of deposits may be determined definitely and correlated with the pressure and temperature at which various chemicals deposit out of the steam. The effectiveness of turbine washing is readily observed. It is hoped that this will prove a distinct contribution to improving turbine availability through knowledge of deposit formation at various pressures and temperatures.

5. Automatic steam-seal regulator and unloading valve. Another source of operating inconvenience, particularly during starting-up operations is the need to maintain proper pressure in the front-end steam seal, and, during normal operation, in the gland steam leakoff line.

The entirely new steam seal and unloading valve are designed to maintain 1 psig in the high-pressure seal before the water seal has become effective. As the turbine begins to pick up load, steam is dumped from the leakoff line to the gland steam condenser until the leakoff pressure has dropped back to 1 psig, which is maintained during normal operation.

The above equipment protects against:

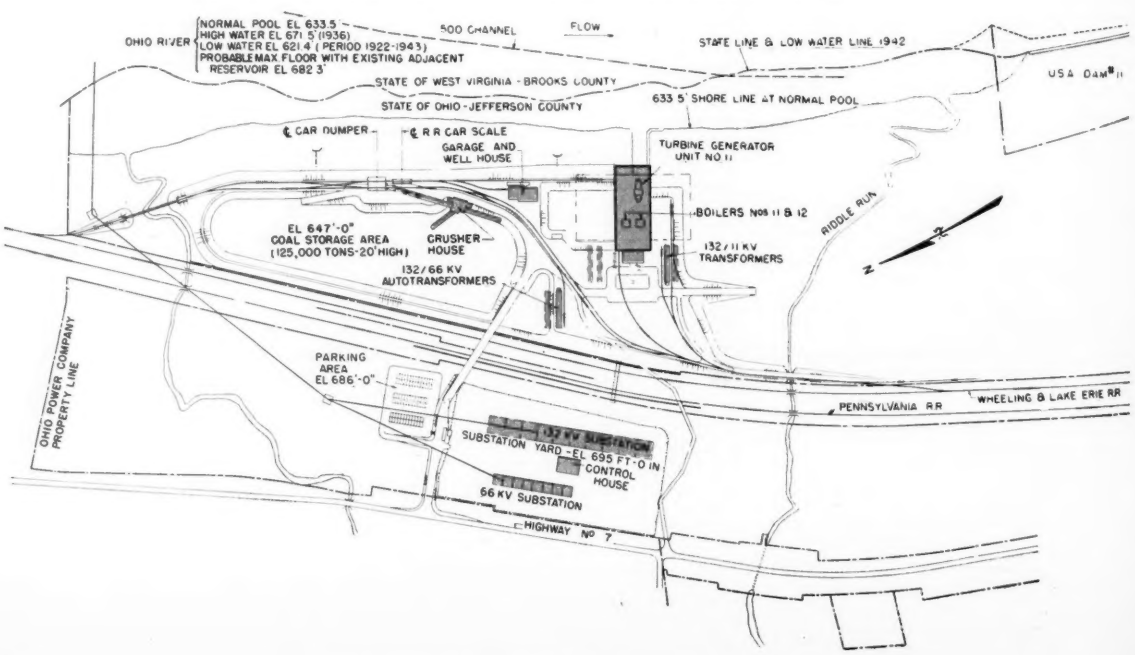
(a) loss of water in water seal during sudden load changes which would result in steam and water being blown along shaft into adjacent bearing causing oil contamination;

(b) precluding vacuum in steam seal especially while at low speed before water seal is effective, which would pull cold air and distort the first stage wheel.

6. Water sealing system. Another operating convenience, particularly for a quick restart after a shut-down, is remote indication and control of the water sealing system on high and low-pressure shaft packings. Sealing water can be turned on and off from the control room from where its pressure and temperature may be adjusted.

7. A motorized valve for control of water flow to the oil coolers and a tem-

Fig. 2. The plant site is 10 miles downstream from Steubenville, Ohio


NORMAL POOL EL 633.5
HIGH WATER EL 671.5 (1936)
LOW WATER EL 621.4 (PERIOD 1922-1943)
PROBABLE MAX FLOOR WITH EXISTING ADJACENT RESERVOIR EL 682.3
OHIO RIVER
500 CHANNEL
FLOW
STATE LINE & LOW WATER LINE 1942
USA DAM 11
STATE OF WEST VIRGINIA - BROOKS COUNTY
STATE OF OHIO - JEFFERSON COUNTY
633.5' SHORE LINE AT NORMAL POOL
℄ CAR DUMPER
℄ R R CAR SCALE
GARAGE AND WELL HOUSE
TURBINE GENERATOR UNIT NO 11
BOILERS NOS 11 & 12
RIDDLE RUN
EL 647'-0" COAL STORAGE AREA (125,000 TONS-20' HIGH)
CRUSHER HOUSE
132/66 KV AUTOTRANSFORMERS
132/11 KV TRANSFORMERS
PARKING AREA EL 686'-0"
OHIO POWER COMPANY PROPERTY LINE
PENNSYLVANIA RR
WHEELING & LAKE ERIE RR
132 KV SUBSTATION
SUBSTATION YARD - EL 695 FT-0 IN
CONTROL HOUSE
66 KV SUBSTATION
℄ HIGHWAY NO 7

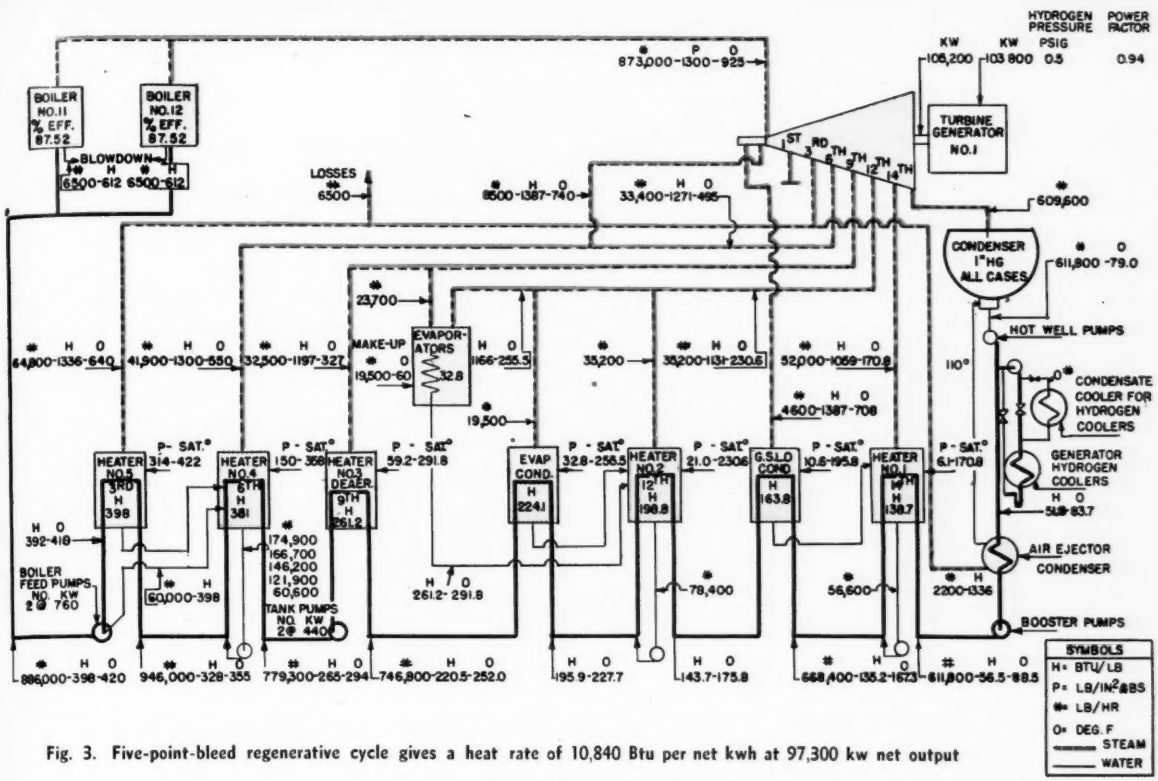


Fig. 3. Five-point-bleed regenerative cycle gives a heat rate of 10,840 Btu per net kwh at 97,300 kw net output

perature indicator assures proper oil temperature to the bearings. Each bearing is protected by remote indicating thermometer and all thermometers are equipped with temperature alarms connected to annunciator.

8. An automatic low vacuum trip works so that loss of vacuum operates the emergency-stop valve and closes off the main steam supply. No atmospheric relief valve is provided; a rupture diaphragm that may be seen on top of the exhaust hood, Fig. 4, is the second line of defense against excess exhaust pressure.

Condenser and Auxiliaries

A 58,000 sq ft Foster Wheeler single-pass condenser serves the 100,000 kw turbine. The tubes are ⅞ in. O.D., 28 ft 9 in. effective length.

Here again special attention was paid to reliability and continuity of operation. Because this portion of the Ohio River is heavily laden with trash and especially leaves during the fall and spring, reversing water-boxes were provided. These permit full reversal of circulating water flow during operation and complete removal of any accumulations of trash on the tube sheets. This applies especially to the felt-like blanket that often attains a 1 in. thickness on the tube sheets which is most difficult to remove except by reversal of flow. In addition, the divided water boxes permit cleaning one-half the tubes while operation continues under slightly reduced load.

The condenser manufacturer was asked to design for as complete deaeration as possible. So far it appears that condenser deaeration needs back-up by a pressure deaerator, but later experience may possibly reverse this present opinion.

Centralization of Control

Centralized responsibility for control was obtained by placing controls and remote operative devices for the boilers, turbine generator, heat cycle, pumps, and electrical switching in a single control station on the main operating floor between the boiler and turbine rooms. Such centralization precludes several operators from working at cross-purposes during upset plant conditions. The operator has before him all pertinent data, indications, and controls required for the operation of the plant.

Such concentration of indications and controls in one location was facilitated by the development of telemetering of flow meters and level recorders.

The combustion controls are the all-electric types. The steam pressure control element imposes a loading voltage on the solenoids of the various control regulators. Boiler air flow is controlled by inlet vanes of the induced draft fans and fuel input by regulating the exhauster inlet dampers. To insure satisfactory control of furnace draft over a wide load range, an additional damper in the forced draft fan outlet ahead of the air heater is regulated while the inlet vanes of the fan are controlled to maintain a constant differential across the regulating damper.

To obtain good coal fineness, the level of coal in the pulverizer is closely controlled. This is accomplished by constant-speed table feeders with variable shear plates; the shear plate position being controlled by a motorized regulator responsive to the differential pressure between the coal and mill suction reference lines.

Buildings and Structures

The normal pool elevation of the Ohio River at the plant is 633.5 ft U.S.G.S. datum. In 1936, the highest average of river water elevation attained 671.5 ft. A thorough study of past flood records indicates a maximum probable flood elevation to be 680 ft which should occur only once in 150 yr and to insure reliability the plant has been designed to be safe and dry during such a flood.

The cross-section of the plant is shown in Fig. 5. The coal bunker is completely sealed by the concrete floor over it; the slots through which the coal tripper discharges are covered by belting which is raised automatically by the tripper to discharge coal. This reduces maintenance cost as the plant stays much cleaner.

The office, laboratory and machine shop portion will not be repeated on future extensions.

A complete ventilating system is installed. All incoming air is filtered and heated air is recirculated. The object is to keep the plant as clean as possible and thereby reduce maintenance. In the summer the forced draft fans take air from over the boilers to assist ventilation. In winter a proportionate amount

Fig. 4. Two tones of green emphasize the handsome appearance of the 100,000 kw turbine-generator

will be taken from outside the plant as required to conserve plant heat.

Reliability as affected by fire hazards was carefully considered. Not only are there many hose connections served from the service water system, but, in addition, an entirely separate fire protection system was installed with two deep-well pumps in widely separated outdoor pump houses. This fire system also has two emergency connections with the service water systems. A fire house was provided at the coal track hopper. Oil-containing equipment such as the two main transformer banks, their oil storage and processing rooms, and lubricating oil storage and processing rooms were especially protected with Cardox carbon-dioxide fire protection. In addition, oil drainage facilities can quickly remove oil released by tank failure or excessive leakage.

Coal

For improving reliability of coal supply, coal can be delivered at present by railroad and by motor truck. About 350,000 to 400,000 tons will be required annually for this initial unit. While the present installation burns about 50 tons per hour, all the coal handling facilities were designed to handle 800 tons per hour which permits filling the bunkers of the ultimate plant during a normal 8-hour day shift.

Rail-delivered coal is unloaded by a rotary car dumper and transported by a 36 in. belt conveyor either directly to the bunkers or to a swinging boom conveyor for yard stoppage. Coal to be stored is handled by 12-ton tractor-scraper units from the pile at the end of the swinging boom conveyor for transportation and compacting on the storage pile. The same tractor-scraper units reclaim coal from storage, feeding it to a hopper that supplies the 36 in. belt conveyor to the plant. The same hopper is used as an unloading pit for truck-delivered coal.

Again with an eye to reliability, to supply the plant with coal from storage under flood conditions which will cover the railroad and incoming highways, a reclaiming hopper at a "dry" elevation will permit delivery of coal to the plant, even with a 685 ft flood elevation.

A typical analysis of the bituminous coal is:

Fixed carbon	43%
Volatile	35%
Ash	12%
Moisture	10%
Ash fusion temperature	2300F
Btu/lb	11400
Grindability	55

A layout has been prepared for receiving coal by river barge if that should ever prove more economical than rail or truck delivery.

The design of the entire project was handled by the American Gas and Electric Service Corp. under the direction of Philip Sporn, Executive Vice President and Chief Engineer.

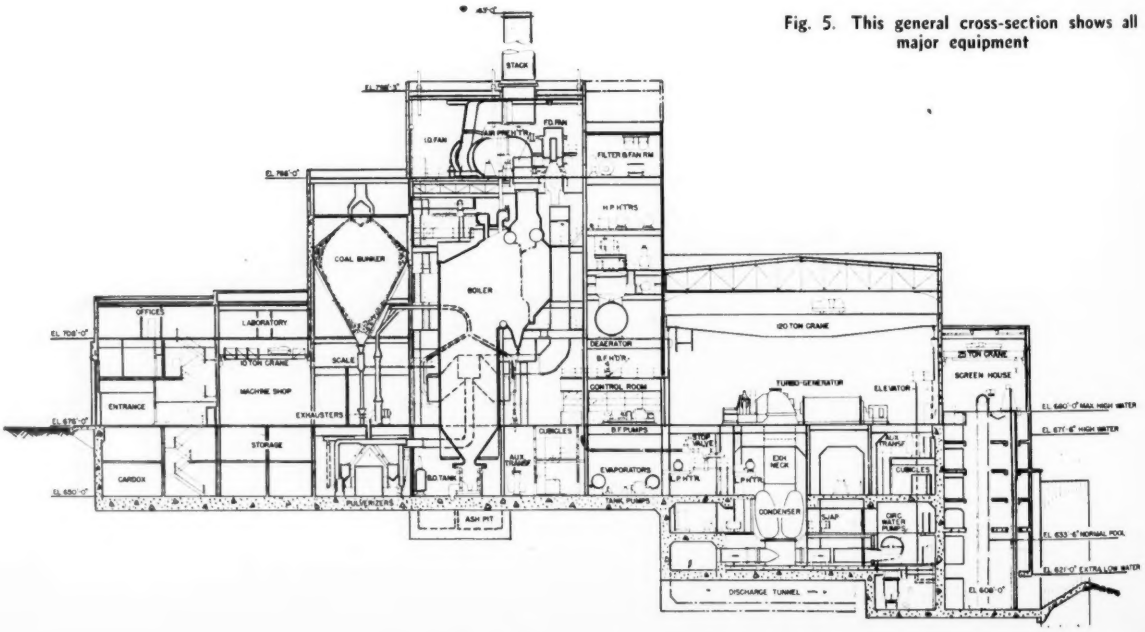


Fig. 5. This general cross-section shows all major equipment

PRINCIPAL MECHANICAL EQUIPMENT — UNIT NO. 1 TIDD STEAM-ELECTRIC STATION

General Data

Name of Station: Tidd
Station Site: Brilliant, Ohio
Cooling Water Source: Ohio River, normal pool elev. 633.5 ft
flood 671.5 ft
Generating capacity: 100,000 kw
Boiler capacity: Two at 475,000 lb/hr, total 950,000 lb/hr
Throttle conditions: 1300 psi, 925 F
Design engineers and construction supervisors: American Gas and Electric Service Corp.
General contractor: Sollitt Construction Co.
Placed in operation: September 28, 1945

Turbine- Generator

Turbine generator—One, General Electric Co., 1800 rpm, 100,000 kw, 0.9 P.F., 13,800-v., 3-phase, 60-cycle.
Steam 1300 psi, 925 F.
Main exciter—One G.E. Co., direct-connected.
Generator cooler—G.E. Co., hydrogen.
Oil coolers—Two, Schutte & Koerting.

Condensing Equipment

Condenser—One, Foster Wheeler 58,000 sq ft, one pass, ⅞ in. O.D. tubes, 28 ft 9 in. effective length, divided water boxes, arranged for complete reversal circulating water.
Circulating Water Pumps—Two, Allis-Chalmers, 54 in. x 48 in. horizontally-split centrifugal, motor-driven.
Condensate and Booster Pumps—Two each, Ingersoll Rand.
Circulating Water Screens—Three, Chain Belt Co.
Screen Wash Pumps—Two, DeLaval.
Trash Rake—Newport News Shipbuilding & Dry Dock Co.

Boilers and Equipment

Boilers—Two, Combustion Engineering Co., bent tube, 8929 sq ft heating surface, 475,000 lb per hr each, operating pressure, 1375 psi, upper front drum 48 in.; upper rear 54 in.; mud 30 in.
Superheaters—The Superheater Co., Elesco type, 15,944 sq ft surface, 925 F.
Furnaces—Combustion Eng. Co., 8754 sq ft heating surface. Dimensions 22.1 x 22.1 x 75 ft high, 29,200 cu ft.
Combustion Control—All-electric type, General Regulator Corp.
Air Heaters—Air Preheater Corp., Ljungstrom type, one per boiler. Inlet air 80 F, outlet air 551 F, gas exit 308 F.
Efficiency of steam generator—87.82 per cent.
Superheat control—Gas by-pass, spray desuperheater and burner tilting.
Pulverizing Mills—Two, Foster Wheeler Hardinge per boiler, 25,500 lb/hr/mill (70 per cent through 200 mesh)
I.D. Fans—Two, Sturtevant/boiler, 500 hp motor, 875 rpm, 126 MCFM at 327 F, 13.4 in. H_2O.
Forced Draft Fans—One per boiler, American Blower Corp., 300 hp motor, 1170 rpm, 145 MCFM at 100 F, 10.5 in. H_2O.
Fan control inlet vanes on both I.D. and F.D. fans.
Flue dust eliminator—Sturtevant integral with I.D. fans.

Coal Handling

Magnetic Pulley—Ding's Magnetic Separator Co.
Coal Sampler—The Thorsten Sampler Co.
Coal Scales—Stock Engineering Co.
Bunker Coal Gates—Stock Engineering Co.
Gyrex Screen—Robins Conveyors, Inc.
Coal Conveyor Tripper—Robins Conveyors, Inc.
Rotary Car Unloader—Birmingham Fabricating Co.
Coal Conveyor Belting—The B. F. Goodrich Co.
Swing Boom Storage Conveyor—Robins Conveyors, Inc.

Boiler Feedwater Equipment

Boiler Feed Pumps—Three, Ingersoll-Rand, centrifugal, horizontally split, 1120 gpm, 1700 psi, 3550 rpm, motor-driven.
Tank Pumps—Three, Ingersoll-Rand, centrifugal, horizontally split, 1050 gpm, 680 psi, 3550 rpm.
Bleed Heaters—Four, Alco Products, closed, straight tube.
Deaerating Heater—One, Elliott Co., 780,000 lb/hr, 2700 cu ft storage.
Feedwater Regulators—Bailey Meter Co.
Heater Drain Pump—Low pressure, Goulds Pumps.
Heater Drain Pump—High pressure, Ingersoll-Rand.
Evaporator—Two, Griscom-Russell, 15,000 to 20,000 lb/hr, single effect.
Evaporator Preheater—Elliott Co.
Gland Steam Leak-off Condenser—Griscom-Russell.
Evaporator Vapor Condenser—Griscom-Russell.
Backwash and Treated Water Pumps—Ingersoll-Rand.

Piping and Valves

Piping contractor—Grinnell Co.
Valves—High and low pressure, Gates and Globes—Lunkenheimer Co.
Small Valves—Manning, Maxwell & Moore.
Non-return Valves—Edward.
Check Valves—Chapman.
Valves—Circulating Water—Chapman.
Piping Covering Contractor—Asbestos Service Co. using Ehret Magnesia Mfg. Co. material.
Piping—Carbon moly ASTM A206-40T, 10¾ in. O.D. x 1¼in. thick, Spang Chalfant, Inc.

Miscellaneous

Pumps—Service Water—Low Pressure—Allis-Chalmers.
High Pressure—Ingersoll-Rand.
Hydrogen Cooler Condensate—Ingersoll-Rand.
Condensate Cooler—Griscom-Russell Co.
Strainers—Elliott Co.
Air Compressors—Two, 500 cfm, 100 psi, Ingersoll-Rand.
Fireless Locomotive—H. K. Porter Co., 50 ton, 600 psi.
Fuel—Bituminous coal, 11,400 Btu/lb, volatile 35 per cent, fixed carbon 43, ash 12 per cent, moisture 10 per cent, ash fusion temperature 2300 F, grindability 55.

THE CENTRAL-STATION INDUSTRY

A REVIEW OF the electric power industry, as to what it has been through and where it is going, reveals immediately a salient fact: there is nothing much wrong technically with the way electric power is produced and handled. The power industry has been sorely tried, in an unforeseen severe test of electric-power systems as a whole. It has been called upon to carry unheard of loads. Many generators and transformers of advanced age were loaded or overloaded. Replacements were few; additions almost none. Yet at no time was there a serious breakdown and never was there a power shortage.

The technical problems of the industry are those of replacements for tired equipment, extensions of existing plants, aid improvements that reduce cost of delivering kilowatts to the customer. In the twelve months after August 14, 1945 the Westinghouse Company alone received orders for 45 central-station type generating units, totalling 1,600,000 kw. Inspection of the ratings and steam conditions disclose certain interesting points. These 45 units are divided as follows: 10,000 to 15,000 inc., ten; 20,000 to 35,000 inc., nineteen; 40,000 to 65,000, eleven; 65,000, one; 75,000, two; 80,000, one; and 105,000, one. As compared with the last major generating-unit buying period (1937-1941) the swing to the high-speed unit has become almost complete. Only the two 75,000 kw units are for operation at 1800 rpm. The average size of unit has significantly increased, as indeed has the maximum rating. The largest single-shaft high-speed (3600 rpm) machine previously was 81,250-kw while now a 105,000-kw unit is under construction and one of 150,000-kw has been studied and could be built.

Steam conditions have, in 1946, moved to the next higher plateau. With two or three exceptions the top had been 950-degree, 1250-pound steam. The 105,000-kw unit for the Sewaren Station of the Public Service Electric & Gas Co. of New Jersey will operate with steam at 1500 psig and 1050 F. The rise of 100 degrees in inlet steam temperature is particularly significant as the amount of fuel consumed to produce a kilowatthour is reduced about four per cent; however each few degrees rise in temperature greatly increases the severity of the metallurgical problem. Turbine engineers are now willing to take this next really big step in inlet temperature because by using a new method of construction and better high-temperature alloys, the accustomed degree of turbine reliability can be maintained.

Salt Lake City Solves Smoke Problem

By **MARGARET THOMAS** Former United Press Staff Correspondent

AFTER thirty years of smoke begrimed winters, the citizens of Salt Lake City, the "Pittsburgh of the West," stand on the brink of success in their perennial fight against smoke, dirt and soot.

By this winter of 1947, if present plans are not interrupted or delayed, Salt Lakers figure Old Sol, who usually is blacked out by smoke clouds for five or six months every winter, will shine on them as he once did on their pioneer forefathers long before smoke became a nuisance.

In this day of modern scientific miracles we may well ask why Salt Lake City, truly one of the most beautiful cities in the world from April to September, has taken so long to extricate herself from this smoke blanket. Yet the answer is simple. It lies in the plain fact that this western metropolis, snuggled so closely against the Rocky mountains, is in effect a geographical bathtub. The valley, 4000 ft. above sea level, is surrounded on three sides by mountain ranges which tower 3000 to 6000 ft above the valley floor, and which prevent the wind from sweeping the "bathtub" clean.

Salt Lake City found, through long experience, that to eliminate the smoke nuisance it had to find an anti-smoke program at least 25 per cent more effective than that of any city of similar size and industrialization.

During the winter months, the wind velocities in this Rocky mountain valley are lower than at any other time of year. This fact, coupled wth a barometric pressure which forces whatever smoke is produced right down to tree top level, has resulted in smoke clouds remaining over this city for as long as 72 hr.

In addition, prevailing winds, swirling from numerous canyons in the nearby mountains, tend to circulate the smoke clouds throughout the valley until every part of the city is covered with the smoke, the carbon, the dust and the dirt carried by the smoke.

Realizing the menace to health and the damage caused by this dense smoke accumulation, Salt Lakers launched several ambitious but inconclusive anti-smoke campaigns in the 1930's. These efforts, while accomplishing some reduction, proved that education and voluntary cooperation were not sufficient.

It was only after these campaigns failed to accomplish material improvement that city fathers realized if they wanted to eliminate smoke once and for all they would have to provide a law strong enough to prevent evasion of the issue.

In 1938 a survey was made to determine the amount of smoke produced by the various classes of smoke producers, including the railroads, commercial and industrial plants and residences. This survey plotted the origin of smoke, the length of time it remained over the city and the frequency at which it was produced. Densities were checked scientifically, soot fall counts were recorded and finally the results were tabulated.

Comprehensive Smoke Ordinance Adopted

At long last, officials and citizens of Salt Lake City knew what they were up against in their smoke elimination program. By 1941, after three years of studying, planning and discussing the various aspects of the problem and after the usual amount of bickering which accompanies such a major civic undertaking, one of the most unique municipal laws in America was adopted by the City Commission.

This all-inclusive law covered all phases of the heating and power field. It set up specific and detailed rules and regulations covering the installation, operation and maintenance of gas, hot water, steam and hot air furnaces, stokers and oil burning equipment. Further, it provided a board of expert engineers with the authority to issue and revoke licenses of all operating engineers and firemen and all power and heating equipment journeymen, contractors and equipment dealers.

In the case of existing commercial and industrial plants, the Power and Heating Division was given the power to make surveys and advise the owners of recommended changes. Failure of owners or operators to comply with these recommendations was made a misdemeanor punishable by $299 fine and a six months jail sentence.

During the first heating season after adoption of the new code, a patrol system was instituted whereby all smoke producers were notified of their violations. Persistent violators were contacted and in most cases, after receiving assistance and recommendations from smoke department personnel, set up a schedule for making necessary corrections. Where conditions warranted, drastic action was taken and immediate corrections were made. Residential violations were treated with discretion to avoid imposing undue hardship on this class. Bad cases, however, were subjected to correction.

Control Exercised over Installation and Operation

The Power and Heating Division governs the installation, alteration, reconstruction and operation of all fuel burning equipment and appliances for the purpose of smoke abatement and elimination of fire hazards. For the installation, alteration or reconstruction of all equipment, from the smallest water heater to the largest steam boiler, all plans and specifications must be approved by the Chief Engineer and a copy left on file in that office before any work may be started on the project. A staff of qualified engineers is maintained by the office for the purpose of checking such plans and to offer suggestions for the betterment of the design, as well as to make certain that they are in agreement with the city's ordinances. An engineering service also is offered and anyone may have his plans and specifications drawn up by the staff for a small fee to cover the cost of engineering.

In order further to govern all such installations, all power and heating equipment dealers and contractors, gas fitters, stoker installers, warm air furnace fitters and steam fitters are qualified by the Examining Board and licensed by the Power and Heating Division.

The Examining Board, consisting of the Chief Engineer as chairman, and two engineers of ten years practical experience, is authorized to grant all such licenses after the proper examination has been passed.

Operation of all fuel burning equipment in excess of ten horsepower not requiring a licensed operator, must be of a design approved by the Chief Engineer.

An applicant for a first class engineer's license must be an engineer, oiler or fireman having at least four years actual operating experience in the management, control or operation of steam boilers, or steam plants. An applicant for a second class engineer's license must have had at least three years of the above experience; and applicants for a fireman's or boiler operator's license, one year experience.

All applicants must be familiar with the elementary combustion processes as well as exhibit sufficient knowledge and ability to remedy any and all emergencies that might occur in a boiler

Effective anti-smoke program found necessary in Salt Lake City . . . Law passed to prevent evasion of the issue . . . All phases of fuel burning covered by the law . . . Patrol system was instituted to notify violators . . . Combustion equipment and its installation must be approved by city official . . . Operators' licenses are issued subject to revocation . . . Ordinance specifies installation conditions of fuel burning equipment . . . Program relaxed during war . . . Results of campaign reported to be gratifying to city commissioners and citizens generally

room. They must know the operation of safety devices required by law, and others that might be provided on the boiler or plant entrusted to their care, and they should be acquainted with the safety code set forth by the ASME.

To any man meeting the above qualifications and passing the proper examination, a license will be issued, allowing the man to assume operating responsibilities in line with his experience and abilities. Persons holding first class engineer's licenses may take charge of and operate any steam or hot water plant. Persons holding second class engineer's licenses may take charge of and operate any steam or hot water plant not in excess of 100 hp. Anyone holding first class fireman's license to operate high pressure boilers shall have the right to operate any steam or hot water boiler. Persons holding second class fireman or boiler operator's licenses may operate low pressure heating boilers and any boiler where the working pressure does not exceed 15 psi and the rating does not exceed 50 hp. In cases of emergency a man with a lower license may assume the duties of an engineer for a period of 30 days provided the employer shall notify the Board of Examiners as soon as possible and submit an application for a temporary permit.

The issuance of licenses to operators, with provisions for revoking same accounts for a great reduction of the smoke nuisance in the city, and this is further enhanced by requiring mechanical firing equipment, or smokeless fuel for all appliances over 3 sq ft of grate area, smokeless fuel being designated as coke, petroleum carbon, natural gas, bituminous coal devolitalized so as not to exceed 20 per cent volitale matter, and fuel oil when burned with an approved type of burning equipment.

Equipment Requirements

As noted above the installation of all power and heating equipment is governed by city ordinances which are briefly as follows:

STOKERS—Stokers are to be of an approved type and shall have a fan capacity of 200 cu ft of air per pound of coal fired per hour, when operating at one inch water column static pressure. They shall have an accessible cleanout for the air chamber of the retort and be equipped with an approved type limit switch set to cut out the stoker at a predetermined pressure or temperature. The horizontal space between the retort and the vertical wall of the furnace shall be filled around with heat resistant material and covered with not less than 2 in. of high temperature refractory material. They are to be provided with a flue that will provide adequate draft when the stoker is operated at maximum capacity and under no condition is a stoker installation to be hand fired.

BOILER SETTINGS—Boiler settings shall be so constructed that mechanical firing equipment may be installed with a minimum furnace volume of not less than 36,000 Btu input per cubic foot per hour when the boiler is operated at maximum rating. When set with a stoker, the minimum clearance from the retort to the nearest overhead heating surface shall not be less than 6 ft, and the minimum distance from the outer edge of the retort to the nearest vertical wall shall be at least 12 in.

WATER TUBE BOILERS—Water tube boilers shall be installed with a minimum clearance of 7 ft, 6 in. from the furnace floor to the bottom of the lowest header and furnaces must be constructed either flush front or extension front to provide a flame travel of not less than 6 ft in horizontal boilers, and 7 ft, 6 in. in vertical or Stirling type boilers. Grate areas are to be not less than 1/60 of the heating surfaces, and the unrestricted damper area not less than 1/5 the grate area. A minimum distance of 16 in. between the burners or the retort and the nearest vertical wall shall be maintained.

FIRE TUBE BOILERS—Fire tube boilers shall be installed with full extension furnaces with a minimum distance of 16 in. from the burner or retort to the nearest vertical heating surface, an unrestricted damper area not less than 25 per cent in excess of the cross sectional area of the tubes and a grate area not less than 1/60 of the heating surface.

HRT BOILERS—Horizontal return tubular boilers shall be installed in accordance with the following tables:

Without Stoker

Boiler Diameter	*Furnace Floor to Shell* *
48 in. and under	60 in.
54 and 60 in.	70 in.
66 and 72 in.	76 in.
78 and 84 in.	82 in.

* Increase dimensions 6 in. for each 25 per cent of excess load above rating.

With Stoker

48 in. and under	42 in.
54 and 60 in.	48 in.
66 and 72 in.	54 in.
78 and 84 in.	60 in.

* Increase dimensions 6 in. for each

Fig. 1, right. Believe it or not, Salt Lake City is blanketed under that cloud of smoke. This picture was taken in February, 1940. Fig. 2, below. In February 1946, the picture of Salt Lake City looked like this, thanks to the efforts of city authorities.

Fig. 3. One cause of pollution that will be outlawed in Salt Lake City after August 1, 1947

20 per cent of excess load above rating.

Horizontal distance from outer edge of retort to nearest vertical wall to be not less than 15 per cent of minimum distance from retort to shell and shall be increased 2 in. for each 20 per cent of excess load above rating.

Unrestricted damper area shall not be less than 25 per cent in excess of the combined internal cross sectional area of the tubes.

FIREBOX TYPE BOILERS—Firebox type boilers rated at less than 90 lb of coal per hour shall have a minimum furnace floor to overhead heating surface dimension not less than 42 in. When installed with a stoker, a minimum clearance of 4 in. from the outer edge of the retort to the nearest vertical heating surface shall be maintained, and not under 30 in. from the retort to the nearest overhead heating surface. For firebox type boilers having a rating greater than 90 lb of coal per hour, the furnace floor to the overhead heating surface dimension is increased 3 in. and the retort to the vertical heating surface dimension is increased 1 in. for each additional 25 lb of coal required per hour. Further, the angular distance from the outer edge of the retort to the bottom row of tubes shall not be less than 30 in.

MISCELLANEOUS BOILERS—Boilers rated at more than 10 and less than 90 lb of coal per hour must have a minimum floor line to overhead heating surface dimension of 42 in. When installed with a stoker the minimum clearance between the retort and overhead heating surface shall be not less than 30 in. and the minimum horizontal distance from the outer edge of the retort to the nearest vertical wall shall be not less than 4 in. The furnace shall have a volume of 1 cu ft for each 3 lb of coal fired per hour at maximum capacity, but in no case is the internal dimension of the furnace or firebox to be below 20 in. For boilers rated at greater than 90 lb of coal per hour, the vertical clearance shall be increased by 1 in. for each 10 lb per hour fired. In all cases where stokers are installed feeding mechanism shall be permanently fixed or set in such a manner that the stoker will not feed more than 3 lb of coal per hour for each cu ft of furnace volume provided.

WARM AIR FURNACES—A minimum dimension of 20 in. shall be maintained for all cast iron bowl furnaces and 22 in. for steel or refractory lined, exclusive of the lining. The furnace shall have a minimum volume of 1 cu ft per 3 lb of coal fired per hour and be so constructed that mechanical firing can be installed in such a manner that the clinker and fire door is accessible, and so located that the fire may be attended without undue restriction. Where mechanical firing is installed the feed mechanism shall be fixed to feed not more than 3 lb of coal per hour, per cu ft of furnace volume. Factory ratings are acceptable unless found otherwise by test, in which case results of the tests shall be used for normal rating.

CHIMNEY AND FLUE CONSTRUCTION—Plants over 25 hp capacity shall provide a stack of sufficient height and size to give a minimum draft of 0.25 in. water pressure over fire in furnace when operating at maximum rating and plants of less than 25 hp capacity, a stack that will provide 0.15 in. of water pressure at maximum firing rate. Unless the height of the flue is greater than 150 ft, the breeching must not drop at any point from the boiler to the stack. Where rectangular breeching is used it shall have a ratio of dimensions not greater than 3 to 2 and a minimum radius of bends not less than the width. The cross sectional area of the breeching for plants not in excess of 1000 hp shall be one fifth of the total connected grate area.

Residences of less than 1600 sq ft of floor area shall have a furnace flue not less than 11 by 11 in. and it shall be not less than 25 ft high measured from the furnace grates. Water heater flues may be not less than 8 by 8 in.

No stack or chimney shall have any ventilating shaft, air ducts, hot water heater connections or other similar openings except that where gas is used for fuel, three appliances may enter the same flue. A standard altitude connection of 17 per cent is applied to all design calculations for stacks and flues.

Program Interrupted by War

Originally, the engineers and city officials estimated that within five years after adoption of the above ordinances the city's smoke problem would be solved.

But one Sunday afternoon, while Salt Lakers and the rest of America relaxed after the usual hectic week, war clouds broke loose in the Pacific and the ensuing four year war almost sounded the death knell for the whole program. Although the basic elements of the plan were protected, war conditions greatly increased the work of the smoke department and threw the time schedule out of kilter.

Threatened fuel shortage due to lack of transportation required additional work on fuel conservation. Replacement of furnaces and other equipment became difficult as America turned her productivity to war goods. In addition, no sooner were firemen and engineers trained and licensed than they were called to war duty with the armed forces. The population of Salt Lake City skyrocketed an estimated 50,000 persons or 34 per cent above normal. And these people required new homes, and these, again, threw an additional burden on the smoke division.

Salt Lake City became a hub of increased industrial and military activity. Rail traffic increased rapidly to about 200 per cent above normal, making it necessary for railroads, one of the major smoke producers in the area, to fall back on once discarded equipment, thus adding to the smoke problem. In addition, the railroads were unable to procure terminal equipment which could be operated smokelessly.

Yet, plagued by the war and its myriad accompanying blockades, the antismoke program went on at half speed and proved conclusively that it is effective. During the past winter, from October, 1945, to March, 1946, Salt Lake City enjoyed approximately 61 per cent less smoke than it endured during the first winter before inception of the new program.

Gratifying Results of Anti-smoke Campaign

When smoke officials finished the five year program early last spring, they and the public were gratified to discover that more than 60 per cent of the smoke which fogged the city in 1941-42 had been eliminated.

True, the program had not accomplished the estimated 75 per cent improvement hoped for when it was initiated, but with a major war and its accompanying difficulties bogging down the program, the 61 per cent reduction was felt more than worthwhile.

The report for 1945-46 compared the scientific readings taken from October, 1945, through March, 1946, with readings taken during a similar period in 1940-41. While showing a decided improvement over five years ago, the report presented one glaring loophole in the antismoke campaign by showing that sootfall in the railroad area of this city

was approximately five times greater than in any other area.

In the other classifications, definite improvement was shown, so much, in fact, that despite the increased smoke in the railroad area the smoke density as a whole had dropped.

During the past winter the smoke density averaged 0.110, a 61.13 per cent reduction from the 0.283 figure recorded five years ago. Normal smoke density, at which no smoke cloud can be seen and visibility is unlimited, is 0.043.

The smoke cloud remained over the city an average of 85 min during the last winter, compared with an average 227 min duration during 1940-41, a reduction of 62.55 per cent. Sootfall during the 1945-46 winter was reduced 60.6 per cent compared with five years ago.

These figures were compiled and released by the city's power and heating division, with W. L. Butler as chief engineer, but citizens were not asked to take the figures as gospel. Instead, figures of the U. S. Weather Bureau, certainly a disinterested party, were compared and they, too, showed a definite improvement in the overall picture.

In the winter of 1941, the weather bureau recorded 174 days of light smoke and 36 days of dense smoke in Salt Lake City. The past winter the bureau recorded only 69 days of light smoke and only one day of dense smoke. In addition, the bureau records pointed out that five years ago there were more "clear, uncloudy" days than during the past winter, but the number of hours of sunshine recorded was much higher last winter than in the winter of 1941.

Reduction in Smoke Violations

Other figures definitely point to the improvement. For instance, more than $300,000 was spent by commercial and industrial establishments in the city for the installation of new smokeless equipment or the rehabilitation of existing equipment.

As a result, the number of commercial and industrial smoke producers dropped from 610 persistent and 246 occasional violators in January of 1941 to 137 persistent and 34 occasional violators during January, 1946. All current violators have indicated their desire to correct their equipment as soon as new materials are available.

Today there are only 7245 dwellings in the city's 54 sq mi which use hand-fired, smoke producing equipment. Compared to the 1941 total of 13,944, the number remaining is indeed small, contributing little smoke to the valley's overcast.

But the single fact still remains that in this valley the railroads, with their coal and oil burning steam locomotives, are responsible for a great portion of the smoke production. Railroads entering Salt Lake City are the Union Pacific, Western Pacific and Denver and Rio Grande Western. During the past five years, these three roads have spent considerable money and effort in cooperation with city authorities in an effort to cut down their smoke.

They have Dieselized their yard equipment to a great extent and at some expense. But increased traffic, the use of old equipment and other war-born factors have made it impossible for railroads to continue their steps toward smoke elimination.

Mr. Butler's report charges the combined railroads with producing more than 48 per cent of the city's smoke. This smoke, he says, cannot be eliminated completely unless all steam locomotives are banned from the city limits, and he recently presented to the City Commission an amendment to the smoke code which provides for this prohibition.

Engineer Butler has estimated that within a year after adoption of his amendment the city will be out from under the pall of smoke for good. In submitting his recent report, he said. "When we eliminate the terrific smoke cloud which originates every morning over the railroad yards and drifts over the city, we will never again have to say, 'How Black is our Valley!'"

Coal producers, representing one of Utah's largest industries, have objected to the adoption of the amendment because of its effect on the industry. They charge that since Utah railroads now use 25 per cent of the coal mined in Utah, the resultant loss of business from such an ordinance would cripple the industry.

Representatives of the railroads, while guaranteeing cooperation with any move made by the commission to eliminate smoke, have pointed out that the prohibition of steam locomotives would result in the discharge of a considerable number of maintenance workers required for steam locomotives but not needed to service Diesel engines.

The City Commission, after hearing all pros and cons on the situation, took the amendment under advisement for 30-60 days with the promise that no interest would be unduly crippled, but with the understanding that the city would act immediately to solve the remainder of its smoke problem in time for the centennial celebration for 1947.

On August 1, the city commission unanimously passed the smoke ordinance outlawing steam engines within the limits of Salt Lake City after Aug. 1, 1947.

A storm of protest immediately issued from coal producers and railroad officials who asserted the city commission had not given both sides of the question sufficient study and had not allowed them a chance to demonstrate their proposals for smoke elimination.

Coal producers repeated their stand that the ordinance would throw hundreds of coal miners out of work. Railroad union officials said the conversion to Diesel power would eliminate jobs for nearly a thousand boilermakers, steamfitters and other maintenance men now required to service steam locomotives.

Shortly after the ordinance was passed the Denver and Rio Grande Railroad Co. staged a public demonstration showing how steam engines fitted with steam jets could be operated without producing smoke. The engines used for the test were not pulling heavy trains during the tests however, and some doubt was expressed as to the value of the steam jets under all conditions.

After observing the tests the city commission was not unduly impressed. In a review of the commission's actions leading up to adoption of the ordinance Major Earl J. Glade emphasized that Salt Lake City intended to rid itself of smoke at any price.

"We have studied this situation thoroughly," he said. "We have given the railroads and coal producers almost five years in which to solve this problem of their own volition and it has not been done. We are not trying to eliminate any industry or cause undue hardship on anyone—our entire object is to eliminate the smoke."

Asked whether the tests would have any influence on the commission's attitude, Mayor Glade said "The city commission will reserve further action until the railroads have had opportunity to show, during the coming winter, whether the proposed steam jets are effective when hauling heavy trains through the city. If the railroads prove to us by their actual elimination of smoke that they have solved the problem, I am sure the city commission will reciprocate the cooperation and amend the ordinance as necessary."

There the situation now stands. The commission has given the ball to the railroads and coal officials. If they score a touchdown during the present winter perhaps the commission will change its ordinance. If smoke beclouds the city this winter the prohibitive ordinance will insure that this is the last winter such a thing will happen. In any event Salt Lake City finally has shaken the smoke nuisance loose. 1947, Utah's centennial year, holds great promise for the former "Pittsburgh of the West."

INDUSTRIAL TEAMWORK

RECENTLY IN an address before a group of Ohio executives, Harold F. Smiddy, management consultant, connected with Booz, Allen & Hamilton, laid down the following principles as those necessary for developing industrial teamwork:

1. Define the objectives of the business so all know them.
2. Establish a clean cut organization structure. Define each man's position.
3. Staff the organization with competent personnel. Select each worker for his ability to do his part in his particular position.
4. Keep them working together in specified positions whose individual duties and mutual relationships are plainly understood by the whole organization.

Small Duct Change Triples Fan Life, Raises Steam Output 24%

By JOHN CASSIE

Research Engineer, B. F. Sturtevant Division, Westinghouse Electric Corp., Hyde Park, Mass.

IN EVERY branch of engineering and business, improvements are continually being made. This means that any business, to keep up with or ahead of competition, must keep abreast with the latest state of the arts applying to that particular business.

The following case history is an example of the way in which a manufacturing concern keeps up with and successfully applies the latest methods in its power plants. This particular company, the Springs Cotton Mills, has various mills, each including its own power plant. The steam generating unit and auxiliaries mentioned below are at that company's Lancaster, S.C. mills, "the largest cotton mill in the world under one roof."

Need for Changes

After this particular unit was installed and had been in operation for a few years, two problems arose: (1) there was the need for higher steam capacity; and (2) operating conditions up to this time had included what was considered excessive flyash erosion, particularly of the induced draft fan wheel. The erosion was so severe that the wheel actually was cut into two pieces. The cutting plane occurred through the wheel blades towards one side of the centerplate; the blades on the other side of the centerplate were not nearly so seriously eroded. The cutting through of the wheel necessitated reverting to the steam-generating capacity that could be obtained by natural draft.

At about the same time that wheel disintegration took place, it developed that at least a 10 per cent increase in steam output was needed from this unit. To accomplish this, one method considered was the increasing of fan speed to the next higher alternating-current speed. This would have meant the expense and time required for removing the motor and its foundation and the substitution of the new, larger motor and foundation. Further, since the original induced draft wheel had cut out in about 2½ years, it could be anticipated that the replacement wheel, at higher speed and load, would last less than 2½ years.

Another alternative would have been to replace the original wheel by one which duplicated it, maintaining the original motor and speed, and in addition, build a plant extension to care for the needed 10 per cent steam capacity increase.

How the Problem Was Analyzed

Since both the problems of steam increase and excessive wheel erosion continuously confront the fan manufacturer, the textile manufacturer conferred with the fan manufacturer, so as to benefit by the latter's experience obtained on the most recent similar problems at other plants. This conference resulted in a first-hand investigation by the writer and representatives of the textile manufacturer's power depart-

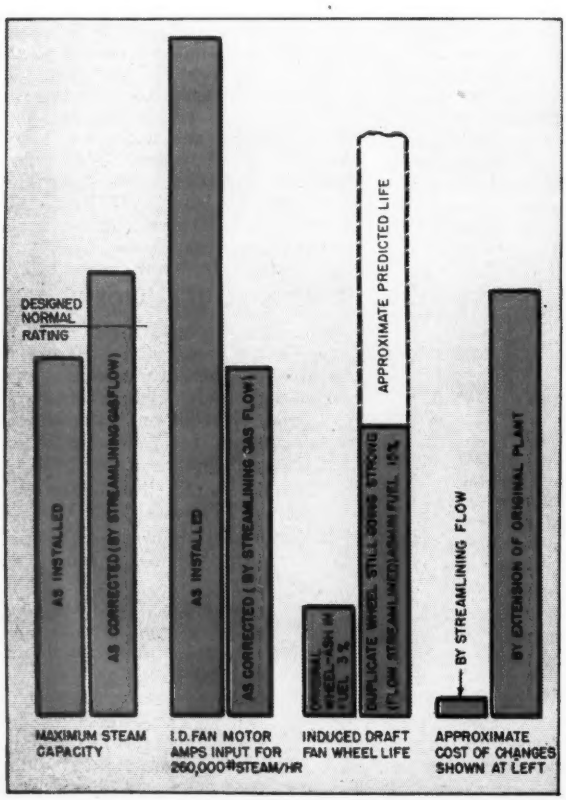

DESIGNED NORMAL RATING
AS INSTALLED
AS CORRECTED (BY STREAMLINING GAS FLOW)
AS INSTALLED
AS CORRECTED (BY STREAMLINING GAS FLOW)
APPROXIMATE PREDICTED LIFE
DUPLICATE WHEEL STILL GOING STRONG
BY STREAMLINING FLOW
BY EXTENSION OF ORIGINAL PLANT
MAXIMUM STEAM CAPACITY
I.D. FAN MOTOR AMPS INPUT FOR 260,000#STEAM/HR
INDUCED DRAFT FAN WHEEL LIFE
APPROXIMATE COST OF CHANGES SHOWN AT LEFT

Fig. 1. Graphical demonstration of benefits derived from streamlining flow in ductwork

THE AUTHOR

JOHN CASSIE is known throughout the power engineering field as "Doc" or "The Fan Doctor." He cures sick and ailing fans and air systems. Like other good doctors, he often finds the cause of the trouble not in the fan itself but somewhere else in the system. The present article, first in a series written especially for Power Plant Engineering by Mr. Cassie, is a fine illustration of his method of attacking such problems.

Now, watch for his next article, which he tells us will be on Mouth Organ Engineering. Everybody has heard how he uses a harmonica in solving noise problems. He'll tell you how he does it and perhaps we can include a picture of him playing the harmonica.

But "Doc" Cassie does not merely do tricks with the mouth organ to be spectacular. His use of it in noise problems is highly scientific; a harmonica is merely a convenient way of carrying vibrating reeds of fixed frequency. He ordinarily uses much conventional test equipment and is particularly skillful with the Pitot tube. If necessary, he builds a scale model of the system to help in analyzing its faults. His prescriptions are designed to step up efficiency in the most economical way. In one plant he tripled the air supply with only a 20% increase in power; in another he increased steam output 16% without adding boilers.

Mr. Cassie, a specialist in mechanical draft, ventilating and other air-handling equipment, has been associated since 1927 with the B. F. Sturtevant Co., now a division of Westinghouse Electric Corp. He received the degree of Mechanical Engineer from Stevens Institute of Technology in 1925, then joined the 3-month student course of Bethlehem Steel Co., Bethlehem, Pa. and continued with that company until he joined Sturtevant.

"Take the stream by the hand and lead it gently around corners" . . . That's a favorite prescription used by The Fan Doctor to cure fan troubles . . . By installing simple guide sheets in the ducts produced the following improvements . . . Increased steam capacity 24%, with reduced fan power . . . Stopped erosion that had reduced draft fan life to 32 months and cut fan in two; replacement fan life already 85 months and going strong . . . Eliminated need for new fan driving motor . . . Plant required 10% more steam; would have been forced to add steam generating capacity costing much time and money . . . Damper control also improved . . . No changes required in physical shape of fan or inlet boxes, only guide sheets inside ductwork . . . These improvements made in face of increase in ash in fuel from 3% to 15% . . . Present fan horsepower only 46% of original for given steam output

ment. This led to the amazingly economical solution shown diagrammatically in Fig. 1. To attain this, the problem was attacked as follows:

Figure 2 shows in detail the "as installed" gas passages from boiler to economizer, Fig. 4, from economizer to fan to stack.

It will be noted that the gas from the boiler flows through a breeching, makes a change of direction in a horizontal plane, then again changes direction, finally entering the economizer vertically downward.

As will be seen from the side elevation of Fig. 2, there is a contraction, caused by sudden reduction of area where the stream leaves the breeching and enters the transition toward the economizer. This concentrates the ash as well as the gas. Further, as can be seen in Fig. 2, plan view, the stream flowing along the breeching crowds up against the two-leaf damper, at which point the ash concentration and gas velocity will be excessive. In the breeching, the gas at B, because of the stream's momentum, overshoots the sharp corner, further exaggerating the contraction of the stream as it leaves the breeching.

Before this stream reaches the economizer, there is insufficient distance in which to effect such stream expansion as would cause full utilization of the area afforded by the confining transition duct between breeching and economizer.

There, upon reaching the right angle change of direction (see auxiliary view A-A, Fig. 2) upstream from the econo-

Table showing summary of gains resulting from duct changes described

	Max. Output Lb Steam Per Hr		Amp Input To Fan Motor	Volume Control Damper Opening	% Ash In Fuel	Months of Wheel Life
"As Installed" ..	210,000		210	100%	3%	32
"As Corrected" .	230,000	(new normal)	189	60%	15%	85**
	260,000		204	90%	15%	85

** Wheel still going strong and expected to last an additional 85 months in spite of the increase of fuel ash content from 3% to 15% and "normal operation load" increase from 210,000 to 230,000 lb per hr (260,000 value, has been attained when needed).

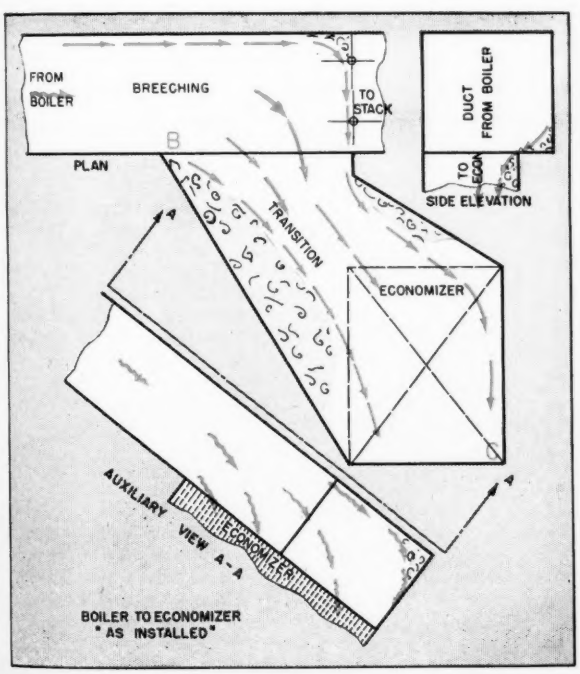


Fig. 2. Ductwork between boiler and economizer as installed, showing faults in gas flow

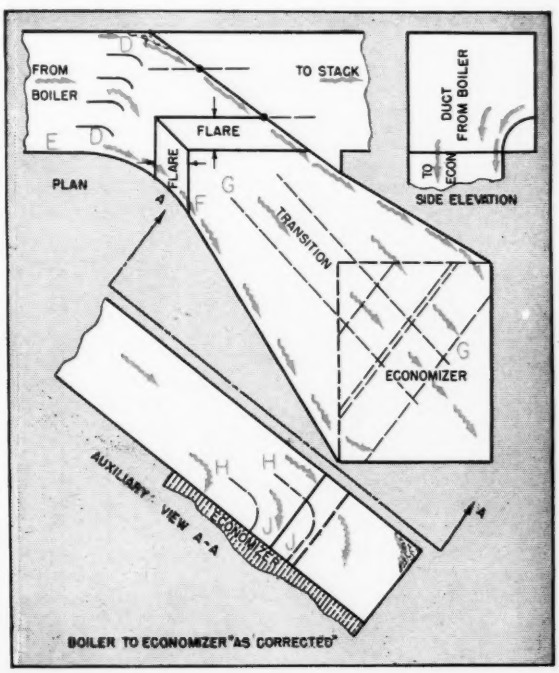


Fig. 3. Ductwork between boiler and economizer as corrected, showing how installation of simple guides and flares produced proper flow

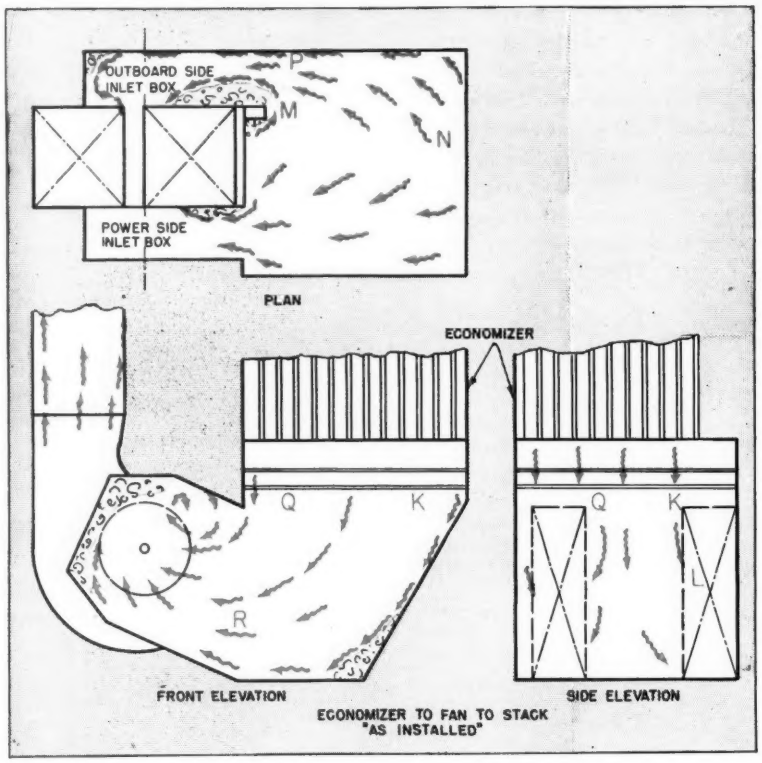


Fig. 4. Ductwork between economizer and induced draft fan, as installed, showing how gas flow was badly unbalanced

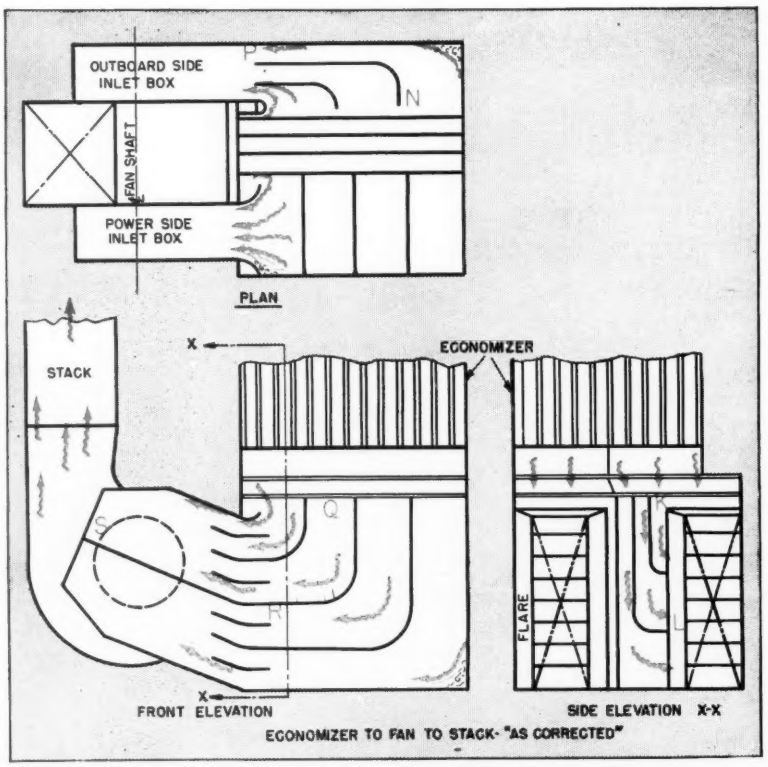


Fig. 5. Ductwork between economizer and induced draft fan as corrected showing how guide vanes and sheets produced proper flow

mizer, the stream jets toward the corner C of economizer. The right-angle turn accentuates the crowding, with the result that some of the economizer tubes handle very little gas while others do much more than their share. The majority of tubes handle quantities other than those for which they were designed.

The result, from the economizer's standpoint, is inefficient utilization of the heat-exchange surfaces, objectionable stratification of ash and gas in and leaving the economizer, and excessive pressure loss through the economizer. Where subnormal velocity exists, the velocity may drop below that necessary to convey the ash. When this occurs, an accumulation of ash deposits at points where it obstructs the flow, increasing the resistance across the economizer.

Many means can be used for studying the nature of the existing flow. The Pitot tube will, if properly applied, indicate points at which objectionable stratification occurs, where excessive pressure losses exist, etc.* Simple means for discovering excessive ash concentrations will be covered in a subsequent article.

In the present case, however, visual observation of the ductwork interior and comparison with previous installations proved a sufficient guide.

How Corrective Methods Were Applied

The summary principle which led to the corrective means is, as in all fluid flow, *"Take the stream by the hand and lead it gently around corners."*

Following the intent of this homely statement, note the corrective means used. In Fig. 3, plan and side elevation, note the flares used at the point where the stream leaves the breeching. This practically eliminates the end contractions on two sides of the rectangular duct cross section. In plan view of Fig. 3 also note that the relocated damper serves the added purpose of preventing stream contraction. This avoidance is assisted by use of corner turns D-D and easing flare E-F. Thus the stream of ash-laden gas will enter the transition with substantially uniform velocity and concentration.

In order to maintain the uniformity of flow, spreader sheets G-G, Fig. 3, plan view, are used in vertical planes and corner turns H-H, Fig. 2 auxiliary view A-A, finally direct the quite uniform stream to the economizer. The leaving ends of J-J divide the economizer *area* into thirds.

Referring to Fig. 5, note how the internal streamlining is accomplished between economizer and fan.

As can be seen from Fig. 4, the flow from economizer to fan inlet boxes is different on outboard and power sides due to the offset relation of economizer and fan. (This probably accounts for the fact that the wheel cutting was more severe on one side).

The gas flow on the outboard side

(*Continued on page 140*)

* See *POWER*, February 1942, Pages 57-60 inclusive.

What is the Most Economical Drive for an Air Compressor?

As indicated in this analysis by a consulting engineer of wide experience, the selection of drive for an air compressor depends upon a number of factors, some of which may not be entirely apparent. Such factors as cost of electric power, steam pressure, demand for heating or process steam, and presence of cheap fuel should be considered

By **WILLIAM W. GAYLORD** Consulting Engineer, Hamden, Connecticut

TODAY we have available, in compressors of 400 cfm and larger for industrial plant use, the choice of motor driven, steam driven, gas engine driven and oil engine driven compressors all of which under proper conditions will give good and economical service so that for any particular case an analysis must be made to determine which is most suitable. In localities where natural gas or very low priced manufactured gas is not available the gas engine driven compressor can be eliminated at once but a more careful study is necessary to choose from the other three.

A motor driven compressor with the motor built in is the most compact and simplest to operate and would naturally be first choice if reliable electric power is available at a low enough cost.

Where there is a demand for low pressure steam for heating or process and sufficient boiler capacity is available the steam driven machine may be the most economical.

Where electric power is not available or the price is high the oil engine driven unit may prove the most economical.

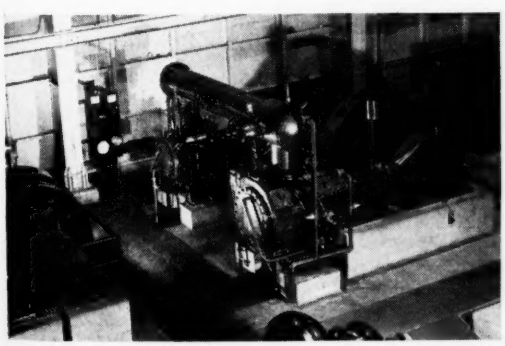
To illustrate points that such an analysis may bring out take the case of a plant having a demand of about 660 cfm at 70 lb gage and using about 100,000,000 cu ft of air per year. This plant now has two steam driven compressors with two stage air cylinders and simple cylinders. Both of these are old and insufficient but the larger one could be used as an emergency spare to a machine to give about three-fourths of present air requirements.

This plant now generates part of its electric power by means of a 200 kva generator belted to a simple 250 hp Corliss engine and purchases the balance. There are two 167 hp boilers operating at 153 psig. The plant heating system is designed to operate on steam at 5 psig. The boilers are relatively new and in good condition but the engine is old. There is a considerable demand for steam for heating more than 7 months per year. A recent survey has indicated that it is uneconomical to continue the operation of the engine and generator and that a modern air compressor of about 825 cfm capacity should be installed to supply all compressed air required. The sub-station and transformers for purchased power are adjacent to the compressor room and of ample capacity to carry a motor driven compressor in addition to present power load. The plant already has sufficient capacitors installed for power factor correction so that a synchronous motor with leading power factor would not be required.

Three types of compressor drive have been proposed, a two stage synchronous motor driven machine using purchased power, a steam driven machine with compound steam cylinders and two stage air cylinders and a two stage machine direct connected or V-belted to a Diesel engine. Which of these types will give the lowest annual costs?

Data on the three types proposed was obtained and an analysis made to show the comparative annual operating costs.

The records for the year chosen as most nearly representing average requirements show that the air compressors ran 5375 hr and that the average use of air was 315 cfm. From the data obtained on the proposed compressors it was estimated that 275,000 kwh of purchased energy would have been required for the compressor with synchronous motor drive, that 363 tons of coal would have been required to produce the steam to run the steam driven compressor, but that of this exhaust steam equivalent to 186 tons of coal would have been used in the heating system leaving 177 tons the net coal charged to the air compressor and that 26,200 gallons of fuel oil would have been required to run the Diesel engine driven compressor.



The motor driven compressor would probably require the least attendance but the setup at this plant is such that no difference in operating labor costs could be expected. As the plant now purchases a large block of power, the power cost for air compressor would be figured as the increment costs in demand and energy.

The estimated comparative annual costs with the three types of drives are shown in Table I.

These figures show that for the conditions existing in this plant the steam driven machine makes much the best showing while the motor driven machine is the most expensive.

In this case the oil engine driven machine was at some disadvantage because the electric power and steam supplies were available at the site of the machine without additional investment, while the complete oil plant was required.

In a new plant each piece of equipment would have to carry its share of the electric sub-station and boiler plant investment. This would add at least $2,000.00 to the investment for the motor driven compressor.

If a high pressure boiler instead of a low pressure boiler was installed to provide steam for the steam driven air compressor the investment for this machine would be increased by at least $10,000.00. Unless the exhaust steam could be used for heating or process work the steam driven machine would be completely out of the picture as the investment for a complete boiler plant would have to be charged against it. In a new plant the difference in attendance labor costs would also have to be considered.

The comparisons would then become approximately as shown in Table II.

These figures indicate that for a new plant the Diesel engine driven compressor would show the lowest annual costs, while the steam driven compressor

would still show a somewhat lower cost than the motor driven compressor if exhaust steam could be used for heating or process.

In a new plant it is probable that the installation of two machines either of which would have a capacity of 0.6 to 0.8 of the maximum demand would be advisable to insure that one machine could be kept in operation at all times, but while this would increase the investment costs it would not materially change the relative costs.

In any general application the compressed air costs shown in these figures must be considered as relative rather than actual and local power and fuel costs may change the relative costs shown. The figures do, however, bring out the fact that a careful analysis based on local costs of power and fuel and the actual or estimated air requirements is needed before deciding on the most economical type of compressor drive.

Table I. Comparative costs for three drives in existing plant

Synchronous Motor Driven Compressor	
Increment demand 100 kw @ $15.00	$ 1,500.00
Increment energy 275,000 kwh @ 1.05c	2,887.50
Oil and supplies	25.00
Inspections and maintenance	150.00
Total operating costs	$ 4,562.50
Charges on compressor investment	1,200.00
Total annual costs	$ 5,762.50
Steam Driven Compressor (Exhaust Used)	
Coal, 177 Tons @ $9.00	$ 1,593.00
Oil and supplies	75.00
Inspections and maintenance	400.00
Total operating costs	$ 2,068.00
Charges on compressor investment	1,320.00
Total annual costs	$ 3,388.00
Diesel Engine Driven Compressor	
Fuel oil 26,000 gal @ 9c	$ 2,358.00
Lub. oil, 400 gal @ 60c	240.00
Supplies	25.00
Inspections and maintenance	400.00
Total operating costs	$ 3,023.00
Charges on compressor investment	1,800.00
Total annual costs	$ 4,823.00
If use of air is doubled and compressor runs same number of hours per year the comparisons become:	
Synchronous Motor Driven Compressor	
Increment demand 100 kw @ $15.00	$ 1,500.00
Increment energy 445,000 khw @ 1.00c	4,450.00
Oil and supplies	25.00
Inspections and maintenance	150.00
Total annual operating costs	$ 6,125.00
Charges on compressor investment	1,200.00
Total annual costs	$ 7,325.00
Steam Driven Compressor (Exhaust steam used)	
Coal, 395 Tons @ $9.00	$ 3,555.00
Oil and supplies	75.00
Inspections and maintenance	400.00
Total annual operating costs	$ 4,030.00
Charges on compressor investment	1,320.00
Total annual costs	$ 5,350.00
Diesel Engine Driven Compressor	
Fuel oil, 40,600 gal @ 9c	$ 3,654.00
Lub. oil, 400 gal @ 60	240.00
Supplies	25.00
Inspections and maintenance	400.00
Total operating costs	$ 4,319.00
Charges on compressor investment	$ 1,800.00
Total annual costs	$ 6,119.00

Table II. Comparative costs of three drives in new plant with high-pressure boiler

Synchronous Motor Driven Compressor	
Increment demand charge	$ 1,500.00
Increment energy charge	2,887.50
Oil and supplies	25.00
Attendance, inspections and maintenance	1,275.00
Total annual operating costs	$ 5,887.50
Investment charges	1,440.00
Total annual costs	$7,327.50
Steam Driven Compressor (Exhaust steam used)	
Coal, 177 Tons (increment) @ $9.00	$ 1,593.00
Oil and supplies	75.00
Attendance, inspections and maintenance	2,400.00
Total annual operating costs	$ 4,068.00
Investment charges	2,500.00
Total annual costs	$ 6,568.00
Diesel Engine Driven Compressor	
Fuel oil, 26,200 gal @ 9c	$ 2,358.00
Lub. oil, 400 gal @ 60c	240.00
Misc. supplies	25.00
Attendance, inspections and maintenance	1,900.00
Total annual operating costs	$ 4,523.00
Investment charges	1,800.00
Total annual costs	$ 6,323.00
In this case if the air is doubled and compressor runs the same number of hours per year the comparisons become:	
Synchronous Motor Driven Compressor	
Increment demand 100 kw @ $15.00	$ 1,500.00
Increment energy 445,000 kwh @ 1.00	4,450.00
Oil and supplies	25.00
Attendance, inspections and maintenance	1,275.00
Total annual operating costs	$ 7,250.00
Investment charges	1,440.00
Total annual costs	$ 8,690.00
Steam Driven Compressor (Exhaust steam used)	
Coal, 395 Ton @ $9.00	$ 3,555.00
Oil and supplies	75.00
Attendance, inspections and maintenance	2,400.00
Total annual operating costs	$ 6,030.00
Investment charges	2,500.00
Total annual costs	$ 8,530.00
Diesel Engine Driven Compressor	
Fuel oil, 40,600 gal @ 9c	$ 3,654.00
Lub. oil, 400 gal @ 60c	240.00
Supplies	25.00
Attendance, inspections and maintenance	1,900.00
Total annual operating costs	$ 5,819.00
Investment charges	1,800.00
Total annual costs	$ 7,619.00

Note—Annual investment charges are based on 12 per cent of cost of equipment and necessary services and auxiliaries installed and ready to operate. Where existing services are ample no investment has been made for these

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Prussian Perspicacity Pops-Up

THEM CLEVER Germans have done it again. The Department of Commerce' "Science Progress," for February reports that superspeed ball-bearing retainers made of plywood were recently developed in Germany. First proposed as a substitute, they proved to be superior to metal retainers, according to United States investigators.

Made of beechwood, the retainers are hardened by a pressure treatment with synthetic resin glue. It is claimed they can be operated without failure at speeds three times greater than can metal retainers now used in the United States.

The two-ply plywood is wrapped around a mandrel to the desired thickness, then heated, compressed and boiled in oil. The retainers are machined from these densified wood tubes. The advantage of these retainers, an investigator reported, lies in their machinability, which gives a smooth, low-friction inside surface, and in the permanently lubricating effect of the hot oil treatment.

We can all cheer up, however; the report goes on to state that, in general, German techniques for the manufacture and use of plywoods are inferior to those of American industry. Heil!

Another development of German scientists, late in the war, was crystalline, synthetic mica which may be superior to natural mica for electrical uses. This product corresponds to natural muscovite mica, widely used in the electrical and electronics industries.

The Germans crystallized synthetic mica by slowly cooling a fused mixture of alumina, magnesium oxide and fuller's earth. The raw materials are heated to 1500 C in a large carbon crucible and then cooled to 1350 C. Mica crystallizes out of the melt during this cooling process, which may take as long as 72 hours. The slower the rate of cooling, the larger the sheets of mica formed. A horizontal magnetic field, applied during cooling, causes horizontal growth of the mica and yields sheetlike laminations characteristic of natural mica. Wunderbar!

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Lubrication—A Job for Skilled Personnel Only

Lubrication too often left to untrained personnel . . . Circumstances alter lubrication procedures . . . Follow recommendations of manufacturer, bearing maker or oil companies . . . Types of bearings . . . Removal, inspection and flushing . . . Effects of over lubrication . . . Frequency of lubrication . . . Lubrication of gearing . . . Chain drive lubrication . . . Special cases . . . Operator should use imagination, foresight . . . Tools, special fittings

By THOMAS TRAIL

IT IS SAFE to say that the years of trouble-free service contained in a machine, whether it be electrical or mechanical, is more directly dependent upon the attention given to the lubrication of its bearings and other frictional surfaces than upon any other single maintenance detail. Too often the vital work of lubrication is left to the inadequate judgment of an employe ill-trained for the work. Adequate, proper and efficient lubrication does not mean merely filling bearing reservoirs with any kind of oil or grease at irregular intervals. Lubrication should be made a skilled profession, and those responsible for this important work should be carefully trained in the intelligent application of each type of lubrication.

It is certainly poor economy to employ skilled workmen to install and repair machinery and then place an incompetent man in a position where a mistake of his can greatly shorten the machinery's useful life, and, what may be even worse, cause costly delays in production.

Each type of bearing requires a particular type of lubrication procedure. Furthermore, the operating characteristics of identical bearings may differ to such an extent as to require entirely different methods of lubrication. For instance, bearings of motors located in excessively hot atmospheres will naturally require a heavier or more heat-resistant lubricant than will those in more normal surroundings. All these details must be taken into consideration if

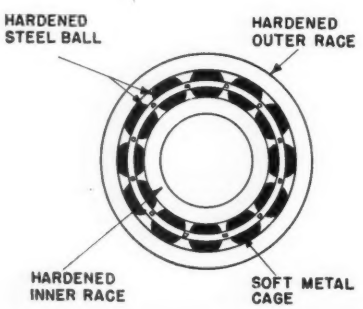


Fig. 1. Overfilling often jams the cage and prevents rotation of the bearings. Continued rotation of inner race will wear flat spots on the bearings

Fig. 2. Checking operation of chain oiler should be done carefully. Make certain it is rotating properly and carrying a sufficient amount of oil to the top

an efficient program of lubrication is to be followed. A chart (Table I), listing each machine and the particular type of lubricant best suited to its requirements, as well as any supplementary details of lubrication procedure, should be prepared. Upon this chart entries should be made that will provide a continuous and comprehensive record of the lubrication of all machinery in the plant.

In general, machinery lubrication requirements can be divided into the following classifications: Grease lubricated ball, roller and plain bearings; oil lubricated ball, roller, plain and sleeve bearings; oil lubricated gearing, chain drives and sliding surfaces; and oil and grease lubrication of other types of bearing surfaces. These requirements can be further subdivided into electrical and mechanical applications.

The recommendations of the machinery manufacturer should be followed as nearly as possible. Any charts or instructions on lubrication furnished by the manufacturer should be kept and consulted. If such information is unavailable, it is wise to seek competent advice elsewhere. Bearing manufacturers publish charts for lubrication of ball and roller bearings, and lubricant makers also publish useful information in booklet form. The purpose of this article is to give a general idea of the proper methods of lubrication for the various types of machinery likely to be met with in industrial plants and commercial establishments.

Anti-Friction Bearings

Ball and roller bearings fall into two general types: oil lubricated and grease lubricated. The oil lubricated type will require more frequent attention, but possesses the advantage that the flushing action of the oil circulating over the bearing will wash any dust, grit or other foreign material down into the bottom of the oil reservoir, where it cannot harm the bearing. The type of oil suitable to use will depend upon many conditions such as temperature, load and atmosphere. Such bearings should be lubricated (if lubricant is required) every three months where the bearings are in normal one-shift-a-day service. For longer daily service such check-ups should be made every month, and where severity of service requires it, every week.

About once a year the bearings should be removed and thoroughly flushed with light oil or ordinary crankcase flushing oil. The housings should be flushed in the same manner. If kerosene is used, dip the bearings into a light lubricating oil before replacing. The lubricant seals should be examined also and any defective ones that do not properly seal the bearings should be replaced. This is very important since the seals serve a double purpose. They prevent leakage of lubricant from the bearings and prevent entrance of foreign materials into the bearings. If grease seals are used in grooves provided for that purpose, the grease may require renewal. Be sure to use the proper type of hard grease for this purpose.

After the bearings have been replaced the housings should be refilled with the proper grade oil. Be careful not to overfill since, when the bearing heats up while running, the lubricant level may

Fig. 3. Gearing may be lubricated by slowly pouring oil on the teeth while the gears rotate

rise sufficiently to cause overflow or flooding.

Grease lubricated ball and roller bearings should be checked for lubrication requirements every six months. If the bearings are in more severe service than usual the checkup should be made every three months, or even every month.

Remove, Flush, Check

Once a year such bearings should be removed and flushed, as explained for oil lubricated bearings, and the seals should be checked for wear. The bearing housings should then be packed half

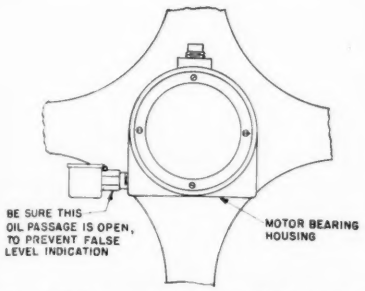


Fig. 4. Make certain that the sight feed passage is open in order to get a proper reading on the oil level

full of the proper grade of grease. Do not fill more than half way since overfilling may create resistance inside the bearing. This can prevent the spacer cage rotating at its proper speed thus causing flat places to wear on the balls or rollers. See Fig. 1. Overfilling also can cause the bearing to heat up excessively and result in thinning of the lubricant, with consequent leakage. Another possible bad effect of overfilling is the creation of pressure within the bearing housing. This can cause leakage of lubricant past the seals and into the interior of the machine. This is especially undesirable on electrical machinery and textile machinery.

Plain Bearings

On plain bearing installations various types of lubricants are employed, according to the particular service. Drop feed oil, wick oil, gravity grease, pressure cup and pressure gun grease, brick grease, etc., are some of the means of lubrication used. Regardless of the kind of lubrication method utilized, such bearings should have only the proper amount of lubricant. Excess lubricant finds its way out of the bearing and may cause damage to electrical mechanisms or goods in process.

It is very important that the proper kind of lubricant be selected. The temperature will be a determining factor as will the method of feeding the lubricant. Where grease is employed in a pressure cup, it should be of a type that will not separate. That is, the oil should not separate from the soap since the soap may clog the cup.

About once a year plain bearings should be flushed thoroughly with light oil or kerosene, as described for ball and roller bearings except that the bearings should not be dismantled. The lubricators, however, should be taken apart and cleaned every six months or oftener depending upon the type lubricant used. Where grease cups are employed special attention should be given to the plunger leathers to see that they are not worn excessively. If they are badly worn they should be replaced. Wick-oiled bearings require a different procedure. The wick should be removed and soaked thoroughly in light oil to remove all dust and grit and then replaced in the bearing housing.

Plain bearings usually require attention daily or oftener, where oil is the lubricant, except when automatic lubricators having storage capacity are used. Grease cups may require attention only weekly but it is better practice to check them daily, if possible. Wick-oiled bearings will not require oiling more often than once every three months in ordinary service. If the service is more severe more frequent oiling may be necessary.

Sleeve bearings usually employ oil as a lubricant. The proper grade is dependent upon the usual conditions of load, speed, temperature and surroundings. Sleeve bearings have an ideal lubricant circulating system. The oil is picked up from a reservoir and deposited on top of the shaft by means of a metallic ring or chain. From here the oil feeds by gravity through grooves cut into the surface of the bearing sleeve, thus depositing a film of lubricant on the under side of the shaft that supports the shaft and prevents metal to metal contact. If the oil level in the housing of such a bearing drops below the minimum level this film will no longer be present and the bearing sleeve, and possibly the shaft, will be damaged. For this reason it is extremely important that the correct oil level be maintained in sleeve type bearings.

The frequency of lubrication checkups on sleeve bearings will be determined by the conditions of design, service and surroundings. Bearings having

Table I. This type of lubrication chart is of great assistance in keeping proper check on lubrication procedures in plant

LUBRICATION CHART

MACHINE	TYPE OF LUBRICANT	FREQUENCY OF LUBRICATION	REMARKS
Motors - 1750 r.p.m. (oil lubricated)	Light motor bearing oil	Quarterly	In temperatures above 90 deg. use medium motor oil
Motors - 3500 r.p.m. (grease lubricated)	Medium cup grease	Quarterly	In temperatures above 90 deg. use fibre cup grease
Motors - slow speed	Heavy motor bearing oil	Quarterly	
Motors - 1750 r.p.m. (grease lubricated)	Medium cup grease	Semi-annually	
Lathes - plain bearings, grease lubricated	Medium cup grease	Daily	
Lathes - plain bearings, oil lubricated	Medium machine oil	Daily	
Lathes - ball and roller bearing	Pressure grease	Quarterly	
Fans - oil lubricated	Light motor bearing oil	Quarterly	In temperatures above 90 deg.-med.
Fans - grease lubricated	Medium cup grease	Monthly	
Silent chain drives - enclosed	Soft cup grease	Monthly	
Air compressor cylinders	Air compressor cylinder oil	Weekly	
Open gear drives	Heavy gear grease	Daily	

reservoirs of large oil capacity will require less frequent examination than those having less capacity. Similarly, bearings in 24-hour service will consume oil more rapidly than those in less constant use. It is a wise plan to check the

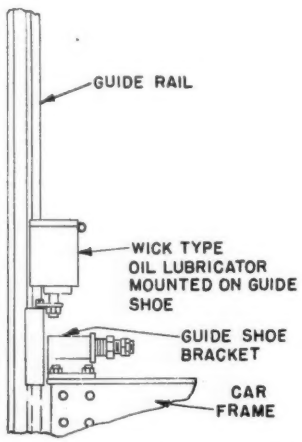


Fig. 5. This sketch shows a satisfactory type of elevator guide rail lubricator

oil level in sleeve bearings weekly. For severe service daily inspection is advisable. At these inspections it is a good idea to also ascertain whether the oil ring or chain is rotating properly (Fig. 2) and whether it is carrying a sufficient quantity of clean oil to the top of the bearing. Sometimes gummy deposits in the oil will cause the ring or chain to stick, thus cutting off the supply of oil to the bearing.

Once a year, sleeve-type bearings and their housings should be thoroughly flushed out with kerosene or light oil. The oil seals should be examined for wear and replaced if necessary. Then the bearing housing should be refilled with the correct grade oil for the particular service. The proper oil level is usually about half way the depth of the filler spout, but this may vary in different makes of bearings. Be sure that the level is high enough to permit the ring or chain to circulate a sufficient quantity of oil over the bearing, but do not fill too full as the level may rise upon heating of the bearing in service and cause overflow or flooding.

For sleeve bearings in severe service it may be necessary to overhaul them more often than once a year. The oil should never be allowed to become dirty and gummy as this may cause the ring or chain to stop rotating or not rotate fast enough, which would stop or reduce the supply of oil and damage the bearing.

Gearing

The proper lubrication of gearing involves such considerations as whether or not the gears are enclosed, the pressures to which the gear teeth are subjected and the temperature of the surroundings.

Gears that operate in the open are naturally subject to dust. As this dust accumulates in the lubricant it reduces its adhesiveness with the result that the lubricant is thrown off the gear teeth due to centrifugal force. For this reason it is much better to apply a small quantity of fresh lubricant to the gear teeth at frequent, regular intervals. The lubricant should possess such features, among others, as ability to withstand the gear teeth pressures, adhesiveness and sufficient fluidity to provide an even distribution of lubricant film over the entire surfaces of the gear teeth. This lubricant should be applied either by heating slightly and applying with a brush or by pouring it on the gear teeth in a small stream while the gears are slowly rotating toward one another. (Fig. 3.)

Enclosed gearing is generally lubricated by a lubricant fluid enough to circulate over the gear teeth and return to a reservoir for cooling. This is accomplished by splash or bath lubrication, generally applied to spur, level, or helical gears, or, in the case of worm drives, by the worm dipping into the lubricant and carrying it to the teeth of the worm wheel. The proper type of lubricant to employ in any enclosed gearing installation will be determined by operating conditions. Gears operating at high tooth pressures will naturally require a

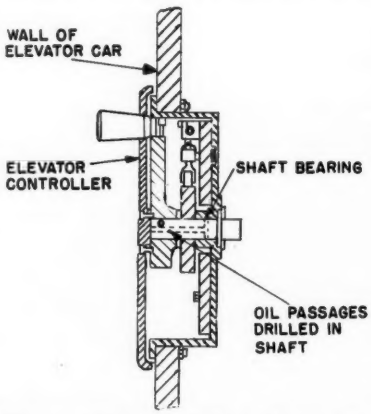


Fig. 6. Passages drilled in elevator car controller shaft to oil bearings not otherwise arranged for lubrication

different lubricant than those operating at lower tooth pressures.

In general, the proper lubricant level will be determined by the manufacturer. This may vary in different makes of machines. The correct level should be maintained for proper and effective lubrication. In gears operating open but having an oil reservoir into which the gears dip, the oil level, unless otherwise decided by the manufacturer, should be such as to just cover the gear teeth on the bottom of the gear. The oil level for worm gears is usually such as to cover half the diameter of the worm. But some worms operate completely covered with lubricant. The ideal level, where possible, seems to be just covering the teeth on the bottom of the worm.

Open and semi-open gearing should be cleaned with solvent or light lubricating oil as often as operating conditions warrant. Whenever the lubricant cakes in the teeth or becomes excessively gummy it should be removed and new lubricant applied.

Enclosed gearing will not require as frequent cleaning as open gearing. But whenever the lubricant becomes excessively gummy or too thin, or should it contain too much dirt, dust or metal particles, it should be removed, and the gearing and enclosing case flushed with solvent or light oil. Then the case should be refilled to the proper level with the correct grade of lubricant.

Chain Drives

Chain drives are lubricated in different ways, according to their design. Some are run open and thus have about the same lubricating requirements as open gearing. Chains operating in an enclosed case may be lubricated either by the splash or bath system, where the enclosing case is oiltight, or simply by hand lubrication where the case is provided merely for protection. Chain drives in general require about the same type lubricants as do corresponding gear installations.

Other Lubrication Requirements

There are other applications where lubricants of various types are employed. Among these are elevator guide rails. These are lubricated by oil or grease. The principal governing requirements are that the minimum amount of lubricant be applied that will insure a constant film on the guide rails to prevent metal to metal contact and consequent rapid wear. (See Fig. 5.) Excess lubricant presents a constant hazard because of the danger of fire.

There are many other parts of machinery that require periodic lubrication and inspection. These may range from several times an hour to once a year or even longer. But the essential thing to remember is that they do require lubrication, no matter how infrequently, and lack of care in this regard is sure to result in wear and the possible needless necessity of replacement.

Some bearings and bearing surfaces are arranged so that they never require attention. These, of course, should not be lubricated, but they should nevertheless be examined at regular intervals to determine whether wear will eventually

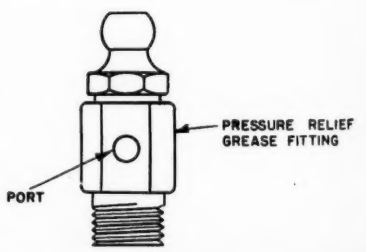


Fig. 7. This type of fitting permits only limited grease pressure inside roller or ball bearing housing. Excess grease escapes through the port

necessitate their replacement. This will provide insurance against unexpected breakdowns. Such examinations may properly be considered beyond the province of the lubrication man, being the obvious duty of the maintenance staff. But a careful and well-trained lubrication man will give his attention to all bearings and will observe wear whenever it becomes noticeable. He can thus inform the proper quarters of his findings before the wear becomes acute enough to cause breakdown and consequent tie-up of production schedules.

An intelligent lubrication man will not stop merely at carrying out the minimum requirements of his work. He will also be observant and painstaking. He will realize fully the necessity of lubrication at every point of frictional contact and will make certain that every such place receives its proper share of suitable lubricant. At times he may discover that the machinery builder has overlooked such a requirement, in which case he can be instrumental in overcoming such a defect by suggesting its correction to the maintenance division. (See Fig. 6.)

The lubrication man should be adequately equipped with the necessary tools to carry out his work in the most efficient manner. This means that not only should he be provided with such modern articles as pressure guns, safety containers for lubricants, cleaning solvents and wiping cloths, but also his work should be made as easy and efficient as possible by the installation of such lubricant fittings and gages as will enable him to apply the proper amount of lubricant to every bearing without unnecessary waste of time, and will provide him with an accurate indication of the lubrication of each bearing at all times. Sight glasses or other types of lubricant level gages will be of considerable help in this regard, as will special grease fittings designed to prevent over lubrication of anti-friction bearings. (See Fig. 7.)

Lastly, but by no means of least importance, the lubrication man should be given every cooperation to carry out his important duties. Time should be set aside for him to lubricate each machine. If safety and proper lubrication requires that a machine be shut down, this should be arranged for on a schedule that will not necessitate unnecessary waste of time either on the part of the lubrication man or the machine operator, and yet will fit in with production schedules.

Lubrication, the life of machinery, has gradually assumed a scientific aspect. No longer is the hand oiler and bucket of grease sufficient requisites for adequate lubrication. Today's high speed machinery, with its high efficiency and close tolerances, requires a degree of scientific lubrication unknown a generation ago. For this reason it is absolutely necessary that correct and careful attention be given to planning a lubrication program if the long life and efficient service built into modern machinery is to be fully obtained.

TUBE CLEANING HINTS—EQUIPMENT

By Fourteen

THIS ARTICLE is specifically directed to those power plant men responsible for the purchase, operation and maintenance of tube cleaning equipment.

Equipment which has been driven at top speed and short maintenance during the emergency is now ready for close scrutiny and some well-deserved repairs. This does not refer to the major equipment, i.e., boilers, motors, generators or process equipment for everybody from the company president down has made sure this type of essential property is in tip-top shape. It will probably take a little time and thought to determine just where the tube cleaning equipment is stored. The tube cleaners, heads and hoses will be in some out of the way locker or room. To get that equipment back into prewar condition is going to take the time of a good mechanic, quite a few repair parts and some logical thinking.

The wise foreman or superintendent realizes that air lines will usually scale and build up pressure drop, hence it is necessary to determine the exact air pressure in the header which supplies air to the tube cleaner hoses. Most tube cleaning motors give maximum performance when the air pressure entering the motor (not the hose or air receiver) is in excess of 80 psi.

Even though the pressure in the header is in excess of 80 psi is no assurance the motor is receiving even close to that pressure. There can be and probably is, a large drop through the lubricator connection and hose if it has been used through the "emergency." If the antiquated lubricator supplying oil to the motor through a small metal tube is still in use, there is probably not enough air reaching the motor to breath, much less drive an air motor at maximum speed and power. Experience has proved that this method of lubrication is detrimental to good operation (even though some of the tube cleaner manufacturers offer this type of equipment to their users.) When oil resistant or synthetic hoses are plentiful again it will be advisable to pull out the metal oil tube and use the hose until the pressure drop becomes excessive, then throw away the lubricator, metal oil tube and oil hose, replace with a modern hose and venturi type lubricator, which only feeds oil when the cleaner is in operation. This

"Funny thing—the smoke smells just like that of the cigars we make, too!"

is an insurance the oil will reach the motor in a fine spray.

The pressure drop through a hose can be roughly checked by putting a gage up-stream of the lubricator connection and one ahead of the motor coupling. Start the motor and check the pressures. If there is any doubt about the accuracy of the gages, change them around. A deflector plate screwed on the shaft to keep the exhaust from interfering with a tachometer reading, will be quite revealing, when one realizes the free speed of the motor is approximately 3000 rpm. This is a point to check with the manufacturer.

When instructions for tube cleaners recommend a good S.A.E. "10" or "20" or "30" or "40" lubricating oil, this means anything from cutting oil to the best grade diesel oil and still the tube cleaner will not be properly lubricated. Tube cleaner motor repairs can be cut 50 per cent by using venturi type lubricators and an oil that is especially designed for this type of service. This is another question to put directly to the manufacturer of tube cleaner motors. One major oil company produces an oil which is almost perfect for this service as has been proved by six years of successful lubrication.

These comments on tube cleaning are quite general, but they cover points which must be clarified before actual progress can be made in tube cleaning performance.

Safety in the Use and Handling of Ammonia

Type of protective equipment which should be available . . . Safety practices in the unloading of tank cars . . . Repair and cleaning of tank cars . . . Showers, fountains, stretchers . . . Tables of characteristics of anhydrous and aqua ammonia . . . Warning signs

AMMONIA is one of the most powerful of all the alkalis. Exposure of a human being to high concentrations may cause severe burns or blindness and inhalation of the fumes may strangle and eventually kill the victim.

In order to arrive at a standard for safe practice in the handling and storage of aqua and anhydrous ammonia the Division of Labor Standards of the U. S. Department of Labor has established the following set of precautionary measures.

Types of Installations

Every refrigerating machine exceeding 3 ton capacity which uses anhydrous ammonia should be placed in a room apart from any other room where more than 5 persons are employed. Machines not exceeding 3 ton capacity, when installed in a room where more than 5 persons are employed, should be substantially enclosed, with an opening to the outside.

Protective Equipment

Wherever anhydrous or aqua ammonia is handled, used in process or as a refrigerant, a Bureau of Mines approved, full-face cannister type mask providing full protection against the inhalation of ammonia fumes should be used. If quantities of more than 1,000 lb of ammonia are used or handled in processes or as a refrigerant (anhydrous only), at least two such masks should be available.

Since the cannister type masks do not produce oxygen, they are suitable only for relatively low concentrations of gas and for brief periods. At locations where high concentrations of gas may be encountered, respiratory protective equipment such as hose masks or self-contained oxygen breathing apparatus should be available, in addition to the cannister type masks.

Hose masks, whereby fresh air is taken from the outside and pumped through the hose attached to the face piece, should be provided for men who must enter and work in high concentrations of ammonia, or in oxygen-deficient atmospheres such as tank cars, storage tanks, pits and sewers handling ammoniacal wastes. The wearer of a hose mask is ordinarily restricted to a working distance of the length of the hose which may be extended to 150 ft.

A self-contained oxygen breathing apparatus provides the wearer with a supply of pure oxygen independent of the atmosphere in which he may be working. The equipment provides greater freedom of movement but the length of time it may be used is limited by the size of the oxygen container.

All respiratory equipment should bear the seal of approval of the Bureau of Mines. Wherever this equipment is stored it should be inspected at regular intervals to make sure it is in proper working order for any emergency.

After using any equipment it should be carefully serviced by cleaning, sterilizing the inside of the face pieces, replacing the cannister if necessary, or replacing the oxygen container with one which is fully charged. The equipment should be stored where it is readily available for immediate use, preferably near an exit. Approved-type safety goggles and protective clothing should be furnished all workers exposed to ammonia solutions.

Unloading Tank Cars

Operations should be performed only by properly instructed workers who are responsible for compliance with regulations laid down by the Interstate Commerce Commission for "Transportation by Rail of Explosives and Other Dangerous Articles by Freight."

Repair and Cleaning of Tank Cars

Protective clothing and approved-type hose masks and life lines should be furnished workers entering cars. The lines should be serviced by a helper on the outside who is fully instructed as to his duties in case of an emergency.

Tools

Only non-sparking tools should be used.

Training

All employes subject to exposure to ammonia fumes should be thoroughly trained in the proper use of respiratory protective devices provided for emergency use. It is important that all employes be acquainted with the location of gas masks or other protective equipment.

Emergency Supplies and Fittings

One or more safety showers of the treadle type should be immediately available in case of splashing of body. One or more of the foot-operated types of bubbler fountains should also be immediately available to flush the eyes.

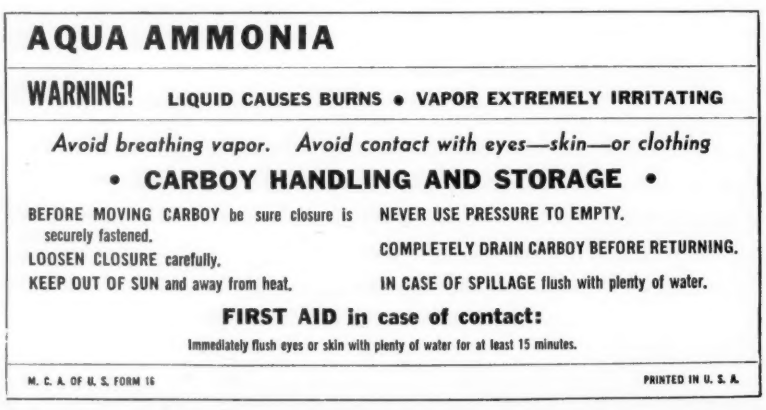

AQUA AMMONIA
WARNING! LIQUID CAUSES BURNS • VAPOR EXTREMELY IRRITATING
Avoid breathing vapor. Avoid contact with eyes—skin—or clothing
• CARBOY HANDLING AND STORAGE •
BEFORE MOVING CARBOY be sure closure is securely fastened.
LOOSEN CLOSURE carefully.
KEEP OUT OF SUN and away from heat.
NEVER USE PRESSURE TO EMPTY.
COMPLETELY DRAIN CARBOY BEFORE RETURNING.
IN CASE OF SPILLAGE flush with plenty of water.
FIRST AID in case of contact:
Immediately flush eyes or skin with plenty of water for at least 15 minutes.
M. C. A. OF U. S. FORM 16
PRINTED IN U. S. A.

Fig. 1. This warning label has been adopted as standard for pasting on all carboys containing aqua ammonia; they were designed and issued by the Manufacturing Chemists Assn. A similar label was developed for use on steel drums holding aqua ammonia.

Table I. Table of characteristics of aqua and anhydrous ammonia

Name	Usual shipping container	Fire hazard	Storage	Fire fighting phases	Remarks
Anhydrous ammonia NH_3.	Steel cylinders or steel tank cars (high pressure) conforming to I. C. C. specifications. I. C. C. requires a green warning label.	Gas density 0.60 (air = 1). Not flammable in air except in comparatively high concentration, seldom encountered under practical conditions; low limit of the flammable or explosive range being about 15% to 16%, upper limit about 25% to 26% by volume (horizontal propagation). Presence of oil increases fire hazard.	Safeguard against mechanical injury and excessive heating of cylinders or tanks. Fire-resistant storage recommended. With combustibles, sprinklered storage recommended. Isolate from other chemicals, particularly chloline, bromine, iodine, and mineral acids.	Soluble water. Hose streams comparatively effective in removing the gas from the atmosphere.	Extensively employed as a refrigerant and in industry. If a pipe or joint breaks, the gas escapes into the air.
Aqua ammonia NH_4OH.	Tank cars (low pressure). Steel drums, glass carboys, 1 or 5 pint bottles. Nonregulatory; no I. C. C. label.	Aqua ammonia does not burn.			Accidental spillage in handling small containers may splash eyes and skin.

Name	FLASH POINT	IGNITION TEMP.		EXPLOSIVE LIMITS Percent by volume			Vapor density air = 1	Boiling point Deg. F.
	Deg. F.	Deg. F.	Ref.	Lower	Upper	Ref.		
Anhydrous ammonia NH_3.	Gas	1204		16.0	25	1.0	0.597	—28
		1204	30	16.1	26.6	1.0		
		1436	26	16.0	25	28.0		
				16.0	27	5.26		
Aqua ammonia.	Non-flammable, being a water solution.						Properties vary, depending on strength	

At least one stretcher and one blanket should be placed where they could be had at a moment's notice.

Light Fixtures

Use only vaporproof type of fixtures with protecting cages. Extension cords —single piece waterproof—should be plugged in only at vapor-free locations. Tanks, line and equipment should be washed free of ammonia before gas or electric welding takes place.

Handling and Storage

Keep ammonia away from other chemicals such as chlorine, bromine. iodine and mineral acids. It should preferably be stored in a sprinklered building and kept cool. Always handle carefully. If good ventilation is provided for the stored ammonia the gas will dissipate.

All instructions printed on the shippers' tags should be scrupulously observed. In case of fire remove the cylinders or notify firemen of stored cylinders.

Anhydrous Ammonia

The hazards arising from the presence of anhydrous ammonia are: Pressure, thermal, explosion, physiological, and irritation of mucous membranes. When the anhydrous ammonia is stored in steel cylinders never drop or permit them to strike against each other violently. Never use the cylinders as rollers or supports; open cylinder valves slowly and use only tools approved by the gas manufacturer.

Never hammer the valve wheel. Do not store near elevators or gangways and do not store empty cylinders with full ones.

Aqua Ammonia

A different set of hazards arises from aqua ammonia; here we are confronted with danger of splashing, burns and, as above, irritation of mucous membranes. When the aqua ammonia is being handled in drums the handlers should be employes who are trained workmen wearing approved-type safety goggles and suitable protective clothing. The drums should be stored off the ground and with the plugs closed. In hot weather ease the plugs but never loosen them by striking the drum. They should be emptied by gravity only.

When the aqua ammonia is stored in carboys thoroughly instruct the men handling the carboys as to safe practices. Provide approved-type safety goggles. Before moving boxed carboys make certain the bottles do not leak and that the stopper is wired in place. Use special carboy trucks and do not use hooks on carboys. Do not "walk" boxed carboys on their edges. Empty them by means of inclinator or siphon. Tilt the neck of full or empty bottles away from the worker. Drain carboy thoroughly before return.

The same hazards exist in the handling of household ammonia as with aqua ammonia. When bottling household ammonia worker should be completely protected with goggles and clothing as described above.

AMAZING as it seems, fatigue tests given two pieces of duralumin, 1/16 in. thick, cemented together with a new plastic cement, show that under bending stresses the adhesive is actually stronger than the metal. Repeated alternating loads up to five million cycles were applied.

OH, HORRORS!! HE BUILT HIS OWN FLOW METER!

By E. Hubert

LACK OF PROPER instrumentation in a power plant, no matter how small, is always a handicap to efficient operation. In our plant we could not get a steam flow indicator to determine the maximum output of a new oil burner and boiler and for other uses because of the shortsightedness of the management; so we made one.

To begin with we had to work with material on hand. First consideration was the mercury U-tube. For that, there were several boiler gage glasses, 18 in. long. These were coupled as shown in Fig. 1 and formed a manometer about 16. in high. To find the pressure difference that could be indicated on that column, 16 in. x 0.493 (for mercury) equals 7.888 psi, or the other way around, 8 psi divided by 0.493 equals 16.277 in. So our glass was long enough for a differential presure of 8 lb at best.

The big problem, how to figure the orifice size, was solved much in the maner of a "Pulverizer Pete." The only formula relating to it that we could find quickly was in an article in POWER PLANT ENGINEERING (also given in the Q & A Book) as follows: $W = 1.9\ A\ K \sqrt{(P\text{-}d)d}$. (What! No Reynolds number?—Ed.) Pressure would be 120 psi. Differential could not exceed 8 lb. Maximum steam flow would not be over 16,200 lb per hr or 270 lb of saturated steam per minute, or 500 bhp for our operating conditions.

The formula then was worked out several times with assumed orifice areas, and the given values of K, until we found 3 in. diameter to be the right orifice size. Not being hampered too much by any dim visions of d/D ratio, vena contracta, and other blonde venuses, proved quite a relief, though such half-baked engineering is not recommended. (More and more horrible! No orifice ratio! No velocity of ap-

proach factor! No co-efficients of velocity and contraction! Shades of Bernoulli!—Ed.)

Installation

The tricky problem of what to do with any condensed steam that may pile up ahead of the bottom of an orifice, in a horizontal steam line, was skillfully bypassed by placing the orifice midway in a 9-ft vertical run of that line as shown in Fig. 2. Provisions had to be made for the displaced water in the U-tube indicator, which was 7/16 in. internal diameter. The volume of that water was computed and reservoirs 4 times as large, to be on the safe side, were made and installed close to the orifice connections, taking great care to place them on the same level.

(E. H. was obviously not a reader of POWER PLANT ENGINEERING from October 1942 to February 1943, when we published The Why, When, Where, What & How of Flow Meter Installation.—Ed.)

Last, the scale was attached to the U-tube as in Fig. 1. The spacing was determined by dividing 1 by 0.493, giving 2.0284 in. per lb pressure. Subdivisions down to 1/10 of a lb were added later, and, of course, done with the utmost accuracy possible with the tools on hand.

It Worked!

After the whole thing was connected with copper tubing and repeatedly tried out with actual steam flow, there were still some grave doubts of the value of the contraption. These doubts prompted the management to borrow and install for a short time a regular steam flow indicator, manufactured by a reliable firm. Comparison showed an inaccuracy of the home-made instrument of less than 1 per cent as compared with the manufactured indicator. (Holy smoke! —Ed.)

As a result of that tolerable reliability the handmade manometer was kept in service. Subsequently, by means of it, not only was the maximum output of the boiler determined, but also a steam loss was detected in one of the machines up in the plant. That loss, because of a faulty connection, had been going on for years, and probably had cost the company several thousand dollars, till it was stopped recently. Moreover, the orifice has a steadying effect on the pulsating water level in the water tube boiler, especially when the steam load is erratic and rapidly changing.

How Chart Was Calculated

To make a direct-reading chart for this meter, we went through the tedious job of working the formula $1.9AK\sqrt{(P\text{-}d)\ d}$ not less than 128 times. This chart shows steam flows in pounds per minute for differentials from ½ psi to 8 psi in ½-lb steps and for gage pressures not absolute pressures, from 90 to 125 psi in 5-lb steps. Several shortcuts and an 18 in. slide rule were used. 1.9AK equals 8.4611 in every instance.

Our feedwater is fairly constant at 190 F, regardless of the above range of pressures and rates of steam flow. From a table of Factors of Evaporation, we first figured the equivalent evaporation for every pressure between 90 and 125 psi. Then we multiplied each steam flow in lb per min by 60, and divided by the equivalent evaporation for the respective pressure. For instance: Steam flow at 120 psig and 8 lb differential equals 170 lb per min; equivalent evaporation from 190 F at 120 psi equals 32.33. 270 x 60 min divided by 32.33 equals 501 bhp. For our needs this is accurate enough. We know of no simpler way of getting similar results; that is the best we can do.

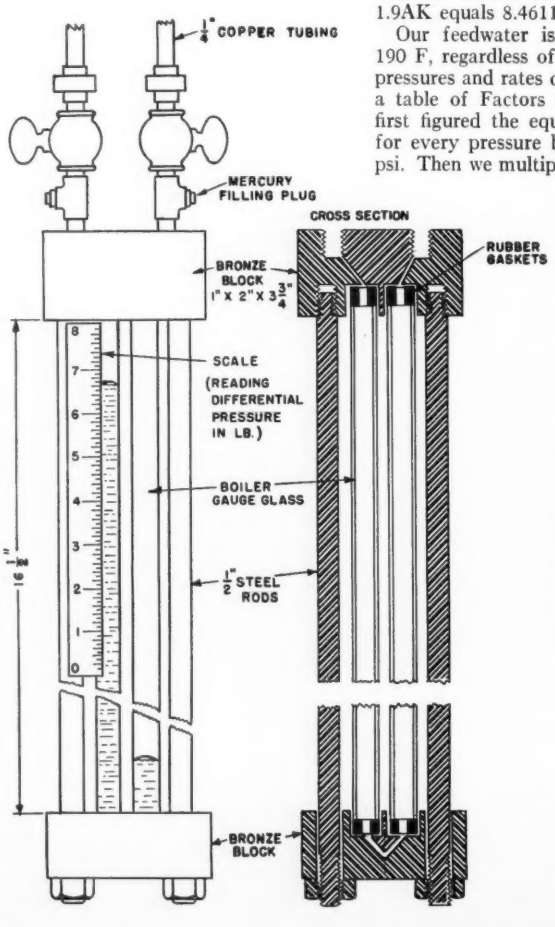


Fig. 1. How E. H's. mercury U-tube for his home-made flow meter was built out of gage glasses and fittings.

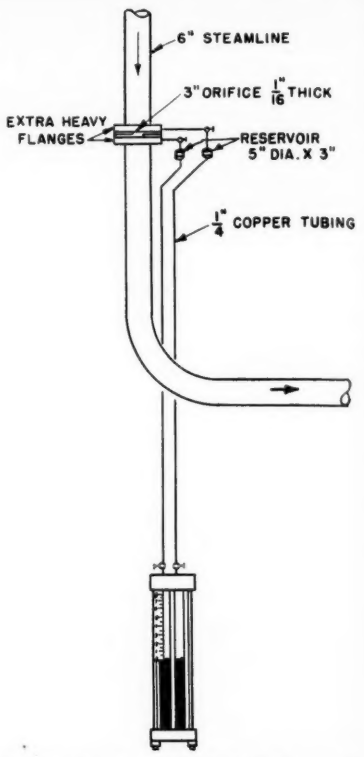


Fig. 2. How E. H. installed his home-made flow meter in a vertical run of pipe

Because of the very slight possibility of steam surges driving the mercury out, we used a 1/8 in. steel ball from a bearing for a check valve as shown in Fig. 3. Due to the high specific gravity of mercury the ball floats up and seals the tubing in case of a surge. That too was tried out repeatedly and it works nicely.

Results as a whole are very gratifying. For instance, we found to our surprise that the starting load on the plant heating system could be as high as 90 bhp during the first half hour, though the running load normally is less than 10 bhp. (Again, Shades of Bernoulli, Herschel, Spitzglass and all the other flow meter gods! And finally, where were all the high-powered flow meter salesmen while all this was going on?—Ed.)

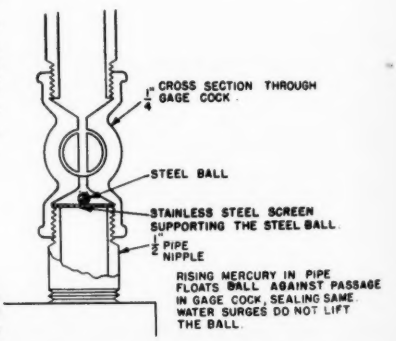

1/4" CROSS SECTION THROUGH GAGE COCK
STEEL BALL
STAINLESS STEEL SCREEN SUPPORTING THE STEEL BALL
1/2" PIPE NIPPLE
RISING MERCURY IN PIPE FLOATS BALL AGAINST PASSAGE IN GAGE COCK, SEALING SAME. WATER SURGES DO NOT LIFT THE BALL.

Fig. 3. Check valve on E. H's. flow meter to prevent blowing of mercury into the line

How Electrical Machines Function—Part III

In this third part of Mr. Andriessen's article he takes up the subject of alternating-current motors and generators . . . He shows the fundamental difference between the d-c and the a-c machine . . . The difference between the synchronous motor and the induction motor and at the end has a word to say about the induction generator

By R. ANDRIESSEN

Electrical Engineer, Crocker-Wheeler Electric Manufacturing Co.

AN ALTERNATING-CURRENT generator, also called an alternator, is a device in which mechanical energy is changed into electrical energy. While a d-c generator produces a current which always has the same direction, an alternator produces a current which reverses its direction periodically. This current changes from zero to a positive maximum, back to zero, then to a negative maximum and finally back to zero again. This change takes place a certain number of times each second, generally 60 times per second. In this case we speak of a current with a frequency of 60 cycles per second. The usual meters do not follow these variations, but indicates a value between zero and the maximum, which is called the effective value. A 60-cycle, 110-volt network supplies a voltage with an effective value of 110 volts.

The underlying principle is the same as in the case of a d-c generator. A coil is rotated in a magnetic field, produced by poles, and a voltage is induced in the coil. Since no commutator is provided for reversing the coil connections, the voltage curve is obtained as shown in Fig. 13.

When a coil side passes the center of a pole, the voltage induced will be a maximum. Midway between two poles, it will be zero; under the center of the next pole it will be a maximum again, but in the opposite direction and midway between the next two poles it has returned to zero. This explains why the frequency, or the number of cycles per second, depends on the number of poles and on the speed with which the coil is rotated. Since this same reasoning applies to the speed of motors, which will later be referred to, it is well to remember this principle.

If a number of coils is distributed around the armature, and all are connected in series, while the ends are connected to two slip rings, a single-phase generator will result. When two sets of coils are used, arranged so that the voltage of one set will be zero at the time that the voltage of the other is a maximum, then a two-phase generator results. Similarly, three sets of coils suitably arranged will form a three-phase generator, which is the usual type. These three sets of coils have of course six ends and the ends can be interconnected in two different ways. In the first place the three corresponding ends can be connected together and the other three ends then form the connecting points for the three lines. An extra line connected to the joint where the three ends are joined forms a neutral. The voltage between this neutral and any of the other lines will be lower than the voltage between any two lines in the ration of 1 to 1.73. This is called a Star or Y-connection (Fig. 14a). The other possibility is shown in Fig. 14b and is called a Delta connection.

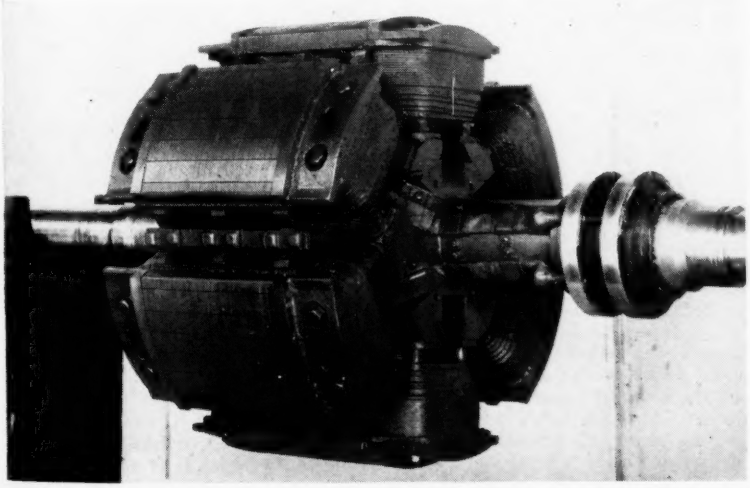
Since these coils must rotate through a constant magnetic field, it is necessary to use a d-c source to provide the current for the field coils on the poles between which the armature coils are rotated. In other words, the fields must be excited by direct current. For this reason, an alternator is generally equipped with a small d-c generator, called the exciter. It may be located on the generator shaft, but it operates independent of the alternator. The fields may also be excited from a d-c network if the latter is available.

It was stated that the coils of the armature must be rotated in the field. However, as long as the number of magnetic lines that pass through the coil changes, it really makes no difference whether the poles and the field stand still and the coils are rotated, or the poles and the field are rotated and the coils stand still. In actual practice the field coils are located on the rotating part (the rotor), while the armature coils are placed on the stationary part (the stator). The mechanical construction becomes much simpler inasmuch as the low-voltage d-c field will require only two slip rings for supplying the field coils with current, while otherwise three slip rings for the high-voltage alternating current would have to be provided.

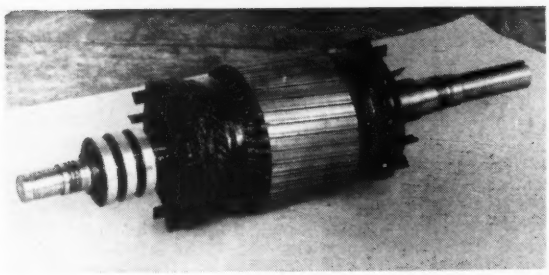
In practice, the d-c field is almost always the rotor. This applies equally to machines having poles similar to d-c machines, called "salient" poles and to high-speed machines, such as turbo-alternators. The latter are driven by steam turbines which operate efficiently at high speed only. The rotor of this type of generator has no salient poles, but the coils are placed in slots that are milled into the rotor forging. The reason is to obtain sufficient strength to withstand the high centrifugal forces set up by the high-speed rotation. The armature coils become the stator coils. The coils of each phase are connected in series in such a way that a corresponding number of "poles" are formed in the stator. However, these poles do not appear obvious when a completed winding is inspected. The speed with which an alternator must be driven can be found from:

Revolutions per minute = Frequency per second times 60, divided by half the number of poles

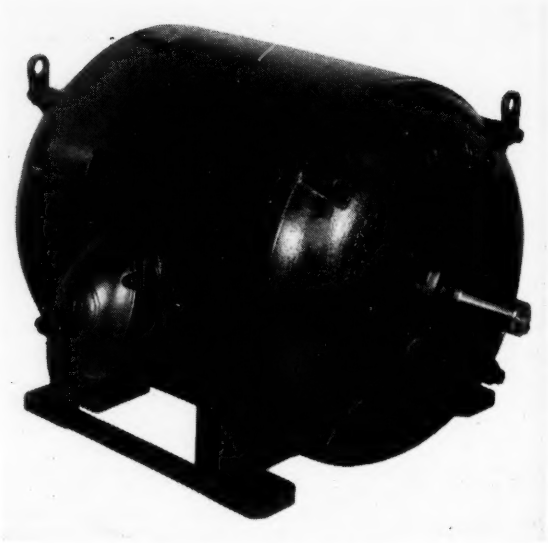
In alternating current there is one more idea to be mentioned, the power



6-pole rotor for a 375 kva synchronous generator. At 60 cycles the speed will be 1200 rpm. The d-c excitation for the coils is supplied through brushes on the two collector rings shown at the right. The damper windings are located in slots in the poles, silver soldered to the end flanges



A-c wound rotor for induction motor. The three slip rings on which the brushes will ride are shown on the left. The rotor slots are skewed to obtain better torque characteristics and to reduce the motor noise



Typical squirrel-cage motor with drip-proof features. This motor is rated 125 hp at 1800 rpm and the frame diameter is 25 in.

factor. In order to understand this, it will be necessary to go back to the statement that the current, multiplied by the voltage equals the power. In direct current this is true, but in alternator current it holds only in the case of a certain type of load. A load is always made up of resistances; they may be the filaments of light bulbs, the coils of motors, etc. The resistance of a material has a constant value when it is placed in a d-c circuit. But when it is subjected to an alternating current, its value depends on other factors in addition to the material. The result is that the multiplication of volts and amperes no longer gives watts, but a value named voltamperes. One thousand volt amperes is equal to one kilovolt-ampere or 1 kva. In order to change this into watts or kilowatts, the kva must be multiplied by a factor which is never more than unity. This factor is called the power factor, and is given in per cent.

The poles of a-c generators are frequently provided with damper windings. These are copper bars embedded in slots in the face of the poles, while the ends are connected by copper rings on both ends of the poles. These bars have the function of counteracting the periodic variations of the engine which drives the generator. For instance, they eliminate the pulsations which would result from the intermittent action of the piston of a slow-speed steam engine.

In practice, some small a-c generators, particularly for low voltages, are built with rotating armatures and stationary field coils. However, by far the most important is the type in which the fields rotate and the armature coils stand still. This includes the turbo alternators,

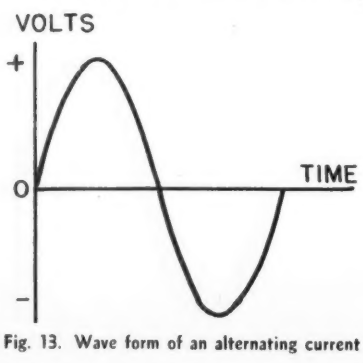


Fig. 13. Wave form of an alternating current

which are built with two or four poles and solid or non-laminated poles. In most other generators, the poles as well as the stator core are made of laminations or punchings made of a special sheet steel. Stator punchings vary from .014 in. to .025 in. in thickness, pole punchings may go up to 1/16 in. The cores are laminated to minimize eddy currents circulating in the iron mass.

Synchronous Motors

Electrically there is no difference between a synchronous motor and a synchronous generator. Actually, any such alternator will run as a motor; when electric energy is supplied, mechanical energy will become available at the shaft extension. In order to understand the operation of the motor, it will be necessary to refer to Fig. 15a, where the current in the conductor interacts with the magnetic field to produce a force. However, if the current in the coil sides is an alternating current, it will reverse its direction, as shown in Fig. 13, and when this happens, the forces will reverse. Since the forces act in one direction just as long as they act in the opposite direction, the net result will be zero, and the coils will not move, but stand still. This means that in a synchronous motor no starting torque is produced by the field and armature windings, but that special means must be provided to bring the motor up to speed. These means will be discussed later in this chapter.

Let the motor be assumed to be rotating at the proper speed. The proper speed will be that which corresponds to the frequency and the number of poles. At the first instant, Fig. 15a will apply and the forces will be acting as shown. If the frequency of the alternating current is 60 cycles per second, the coil side A will have arrived at the position in Fig. 15b one quarter of a cycle or 1/240 second later. According to Fig. 13, the current at this instant is zero, and no forces will result. Figure 15c shows the conditions one quarter cycle later. Figure 13 shows that the current in coil side A, which has now arrived at the south pole, will have reversed, so that the force will continue to act in the same direction. In this manner a torque is produced when the relations between the cycles and the speed are right. This means that the motor always operates at a constant speed, called the synchronous speed. It does not slow down when the load increases, for which reason electric clocks and phonographs are equipped with motors operating on

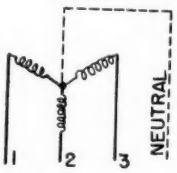


Fig. 14a. Star connection

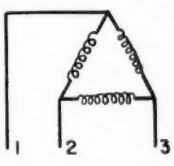


Fig. 14b. Delta connection

this principle. For a 60-cycle motor this speed will be 7200 divided by the number of poles.

There is another method which explains this action. Since this explanation will be used later for another type of motor, it will be given here. In this method, the d-c field is to be the rotor and the armature coils are located in the stator, and are standing still. Figure 16 illustrates a two-phase stator winding. In Fig. 16a, it is assumed that the current in phase I is zero; according to the definition of a two-phase system, the current in phase II will then be a maximum. If the dots indicate currents toward the observer, and + signs currents away from the observer, then the current in phase II produces fields as indicated by the arrows. In Fig. 16c, which shows the conditions 90 deg or one quarter cycle later, the current in I is a maximum and in II it has become zero, resulting in fields which also seem

to have rotated 90 deg. In Fig. 16c, the current in I is zero again, and that in II is a maximum, but reversed as compared to Fig. 16a, because the current is now reversed (see Fig. 13). Figure 16d shows the same with the current in I a maximum but of opposite direction to Fig. 16c. It, therefore, appears that the periodic variations of the alternating current cause the magnetic field of the stationary armature coils to rotate around the machine with the same frequency as that of the alternating current.

This rotating field then interlocks with the field of the rotating d-c poles, so that the rotor will rotate at the speed determined by the frequency and the number of poles.

It was stated that a synchronous motor does not develop any starting torque. For this reason, they are always equipped with a winding in the pole faces, similar to the damper winding of a generator. This winding acts as an induction motor and brings the generator almost up to speed. During this period of starting the d-c field is not supplied with current. When synchronous speed has almost been reached, the d-c field is excited and the motor will "pull into step," meaning that it will speed up to the synchronous value. The action of this "squirrel-cage" winding will be discussed under induction motors.

Practically all synchronous motors are of the rotating type with the armature coils standing still. This does not apply to small specialty motors for clocks,

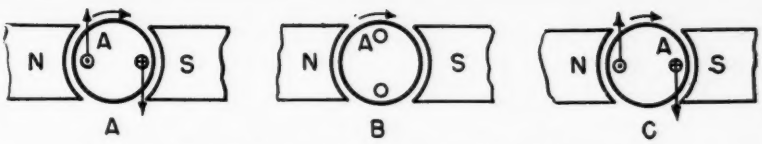


Fig. 15. Showing the principle of operation of the synchronous motor

etc. Synchronous motors are generally provided with an exciter, which is a d-c generator (generally a shunt generator) that supplies the direct current for the field coils. The speed of a synchronous motor can again be determined as cycles per second times 60, divided by half the number of poles. For 60 cycle motors this is equal to 7200/No. of poles, for 25 cycle motors 3000/No. of poles.

Induction Motors

Induction motors, also called asynchronous motors, differ from the previously discussed synchronous motors in that they do not have a d-c field, but operate directly from a-c lines. There are two types, the squirrel-cage motor and the slip-ring motor. Both operate on the same principle.

This is the principle which was illustrated in Fig. 16. The stator winding of a "polyphase" motor, although standing still, produces a magnetic field which rotates around the bore of the stator core. When a coil is placed within this bore, then the number of magnetic lines through the oil changes. From the law of magnetic induction it is known that currents will be induced in the coils. These currents in turn will form magnetic fields around the coil sides, and the interaction of these fields with the field produced by the stator winding will result in forces on the conductors. These forces will produce the torque which turns the rotor.

Should the rotor rotate at "synchronous" speed, that is just as fast as the rotating stator field, then the number of magnetic lines through the coils would no longer change, but would have a constant value. But in that case no currents would be induced, and therefore no torque would result. The rotor would then slow down and again cut the magnetic field. This reasoning proves that the rotor speed must be less than the speed with which the stator field rotates, if torque is to be produced.

For this reason, these induction motors always run slower than the corresponding synchronous motors and will slip behind the synchronous speed. The more it slips, the more magnetic lines will be cut, and the higher the torque will be. This slip is generally less than 5 per cent of the synchronous speed, and increases as the load increases.

The rotor of a squirrel-cage motor consists of a number of conductors, embedded in the rotor core and connected at both sides by means of end rings. There are no external connections, but the winding is short-circuited on itself, the current circulating through the conductors and end rings. Since this motor is on all counts the most simple, rugged and trouble-free, it has gained the most importance.

The rotor of a "wound-rotor" or "slip-ring" motor is provided with a polyphase rotor winding, consisting of coils. The coil ends are connected to slip rings, and the current passes from there through brushes to an external device for adding resistance to the rotor circuit. At full speed, the windings are short circuited, but during starting and if a lower operating speed is required, a certain amount of resistance remains connected between the phases. A speed ratio of 1 to 2 can generally be obtained in this way.

The speed of these motors depends on the manner in which the stator coils are connected together. These connections form poles, which cannot physically be seen, but which nevertheless exist magnetically. The approximate full load speed can be found by taking 95 per cent of the synchronous speed, which can be determined from the same relation as given under a-c generators:

$$\text{Speed} = \frac{\text{Cycles} \times 60}{\text{Half the poles}}$$

Single-Phase Motors

It should be noted that "polyphase" windings cause a rotating magnetic field.

Exploded view showing the parts of a 5 hp, 1800 rpm squirrel-cage motor

1. Stator frame with core and windings
2. and 21. Bearing brackets
3. Oil hole cover
4. Pipe plugs
5. and 6. Oil cups
7. Pipe nipple
8. Bearing set screw
9. Oil ring
10. Sleeve bearing
11. Lock washers
12. Machine screws
13. Squirrel-cage rotor with core and windings
14. Connection plate
15. Rating plate
16. Junction box cover
17. Screws and lock washers
18. Junction box gasket
19. Front bearing bracket snap cover
20. Junction box
22. Gasket

Single-phase windings do not have this characteristic. This can be proved by performing the steps shown in Fig. 16 for such winding. The field increases and decreases, but does not rotate. The result is that at standstill the single-phase motor produces no torque, so that separate auxiliary means are always provided on such motors: once the motor has come up to speed, torque will be developed, so that these auxiliary starting means may then be taken out of action.

Without going into the theory of operation because it is rather complex, it may be said that there are three main types.

1. The shaded pole motor
2. The split-phase motor
3. The repulsion-start motor

1. In the shaded-pole motor, field poles are used similar to those in d-c machines. A slot is provided in the center of the pole faces and an auxiliary short-circuited coil is placed around one half of the pole by utilizing this slot. This extra coil on one half of the pole causes sufficient distortion in the field to bring the motor up to speed. At full load its losses are small, so that it can remain in the circuit.

2. As its name implies, the split-phase motor uses means for subdividing the single-phase windings into two parts. By a proper selection of the electrical values of the two parts, two different phases are created during starting. Once the motor has come up to speed as a result of the torque developed by the two phases, a centrifugal switch may remove the second or starting winding from the circuit, so that the motor will operate as a single phase motor.

There are three ways in which this starting winding can be obtained. In the first place by giving it a higher resistance. In the second type, a reactor is inserted in the starting winding, and finally, a capacitor may be used. A centrifugal switch which operates when a certain speed is reached, cuts out the starting winding.

The capacitor motor is a split-phase motor in which the capacitor is not taken out of the circuit after the motor has come up to speed, but is used for other purposes under full operating speed. These motors may be built with one or two capacitors (also called condensers), depending on the characteristics required.

3. The repulsion-start motor has an armature like a d-c series motor, and is equipped with a commutator. During the starting period, torque is developed on the principle of that type of machine. When the motor has come up to speed, a centrifugal device short circuits the armature coils and lifts the brushes off the commutator. The rotor will then operate as a squirrel-cage rotor.

There is one more type of motor which will operate on a single-phase source. That is the universal motor. This really is a small series-wound commutator motor which is capable of operating on either direct current or on alternating current. They are found in small fans, vacuum cleaners, and other appliances.

Single-phase motors are used only where three-phase power is not available. For this reason they are limited to small sizes, although they are built in the fractional horsepower group in very large numbers. They have certain disadvantages which make them largely unsuitable for power applications.

Induction Generators

Induction motors may be used as generators by driving the rotor at a speed which is higher than the synchronous speed. However, the characteristics are such that it must operate in conjunction with synchronous generators or motors, and for this reason it is rarely used for generating purposes.

Induction motors are built in large numbers. The NEMA, or National Electrical Manufacturers Association, has standardized on the various sizes, so that motors built by different manufacturers are interchangeable so far as shaft height and mounting hole dimensions are concerned.

Squirrel-cage motors are designed to have various electrical characteristics:

1. Those which have a normal starting torque and a normal starting current.

2. Those which have a normal starting torque, but are specifically designed to have a relatively low starting current. By starting current is meant the original inrush of current, which under normal conditions may be as high as six or seven times the full load current.

3. Those designed for a high-starting torque and low starting current. They are designed to come up to speed rapidly under load.

4. Those designed to operate at a high value slip. At full load the slip will be approximately 9 per cent. This is done to cushion the effect of intermittent changes in load, as in punch presses, etc.

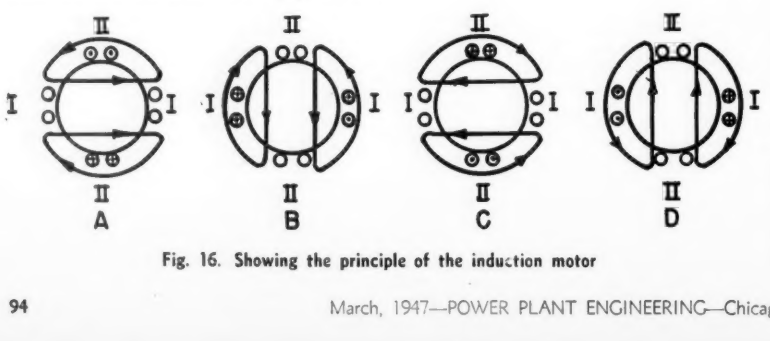


Fig. 16. Showing the principle of the induction motor

Stator frame with core and windings. Can be used for squirrel-cage and wound-rotor induction motors and also for synchronous motors and generators

5. Elevator motors, in which the slip is increased to values as high as 15 per cent for smooth operation.

In addition to these electrical modifications, there are numerous mechanical variations which depend on the purpose for which the motor is to be used. One such variation deals with the degree of enclosure, such as open, protected, drip-proof, totally enclosed, fan-cooled, etc. Other variations deal with the duty cycle, the method of mounting and the type of bearings.

It is possible to build squirrel-cage motors to give more than one speed. This can be done with one winding, by reconnecting the coils to give a different number of poles. It can also be done by putting two separate windings in the stator slots. Single-winding two-speed motors can be designed to give constant horsepower, constant torque or variable torque at the two speeds.

ON LAND OR SEA

I WISH TO express my thanks to the publishers and the others who make this magazine possible.

A short time ago, I changed from sea engineering work to stationary and field engineering. I find, much to my dissatisfaction, that most of the engineers like myself who spend most of their time at sea, are interested in the new developments that affect marine engineering, and in that way become somewhat out-dated as to industrial and power plant developments. Therefore I find much equipment and many new methods pertaining to shore installations that I know too little about.

Now that I am compelled to stay in power plant work—or I should say, on the beach—I find I have a lot of catching up to do. It is because of this fact (and your publisher makes it a lot easier) that I wish to express my thanks. By bringing us the latest literature and publications put out by the manufacturers we fellows in the field are given a better chance to stay abreast of coming developments.

Los Angeles LAWRENCE W. LAPAGE

FOR THE PLANT ELECTRICIAN

SIMPLIFYING THE CALCULATION OF VECTOR RESULTANTS

By C. O. vonDannenberg

Described here is an interesting and very simple method of calculating vector resultants. This method is particularly applicable in the calculation of alternating current problems where high values of current are involved.

THE GREATER number of calculations for a-c problems involve solutions requiring a vector resultant for two values having a 90 degree relation to each other. It seems unnecessary except in passing, to refer to the direct method of calculation, which is of course, the basic proposition one learns in the study of plane geometry, and from the right angle given in Fig. 1 can be written

$$C^2 = A^2 + B^2 \qquad (1)$$

The values of A and B are the values usually available as in a circuit with a lagging current A is the in-phase (watt)

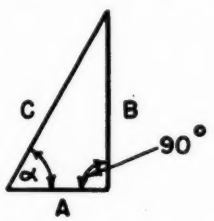


Fig. 1. Basic relations in a right triangle

component while B is the quadrature (var) component. It follows without elaboration that:

$$C = \sqrt{A^2 + B^2} \qquad (2)$$

but should A and B have values in hundreds or thousands, the arithmetical effort, even through slide rule use becomes cumbersome.

If then we divide through equation (1) with A^2 or B^2 we get:

$$\frac{C^2}{A^2} = 1 + \frac{B^2}{A^2} (3) \text{ or } \frac{C^2}{B^2} = \frac{A^2}{B^2} + 1 \qquad (4)$$

Solving for C in (3) and (4) we get:

$$C = A\sqrt{1 + \left(\frac{B}{A}\right)^2} \qquad (5) \text{ or}$$

$$C = B\sqrt{\left(\frac{A}{B}\right)^2 + 1} \qquad (6)$$

It is clear from the fundamental basic relations that A, B and C bear the fixed relation of 3, 4 and 5, hence the value under the radical sign, if we assume A = 3 and B = 4 will be $\left(\frac{4}{3}\right)^2$ for (5) and $\left(\frac{3}{4}\right)^2$ for (6), giving relative totals of $\frac{25}{9}$ and $\frac{25}{16}$ resulting in square root values of $\frac{5}{3}$ and $\frac{5}{4}$; the last values then show values of C:

$$3 \times \frac{5}{3} = 5 \text{ and } 4 \times \frac{5}{4} = 5$$

When, however, one has an actual problem to solve the solution may become a bit more involved and care is needed in the application and as an actual example we can assume a resultant voltage (C) to be 600, with a power factor of 0.8; this gives a var or quadrature factor of 0.6. The two components then are:

A = 600 × 0.8 or 480 and B = 600 × 0.6 or 360

Substituting in (5) and (6) we get

$$C = 480\sqrt{1 + \left(\frac{360}{480}\right)^2}$$

and

$$360\sqrt{\left(\frac{480}{360}\right)^2 + 1}$$

The solutions can be made very rapidly using a slide rule both resulting in a C value of 600. The direct way would be as per formula (1) to add 360^2 and 480^2 or 230,400 plus 129,600 giving a total of 360,000, from which it follows the square root value is 600. It requires no argument to indicate the tediousness and possibility of error when either A or B are sizable numbers when using the direct method just described.

Taking the ordinary type of slide rule on which is shown the A, B, C and D scales the resultant can be rapidly obtained as follows: Taking formula (5) we place 480 on C scale over 360, $\frac{B}{A}$ see Fig. 2, on the D scale, as shown in Fig. 2.

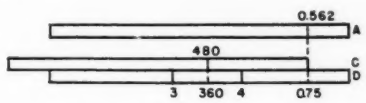


Fig. 2

The actual value of the quotient is 0.75; since the A scale values are the squared values of the C and D scale we obtain at once on the A scale a value read as 562 on the scale (actually it is 5625 or correctly 0.5625); now as shown in the formula add one (1) to 0.5625 or on the rule scale as close as we can read it 1.562, Fig. 3, this becomes 1.25, its square root value

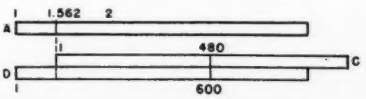


Fig. 3

on the D scale; now place 1 on the sliding C scale over 1.25 on the D scale and under 48 (480) on the sliding C scale we find 6 or 600 the value required. The actual performance takes seconds to carry out with even average practice.

If we use formula (6), we have an $\frac{A}{B}$ value of $\frac{480}{360}$ which is 1.33 on the D scale and 1.773 on the A scale; adding one (1) to this we get 2.773; setting 2.773 on the A scale we get 1.67 on the D scale; place one (1) on the sliding C scale over 1.67 we find on the D scale under 36 (360) the value 6 (600) indicating the application of either formula (5) or (6) to this problem.

The reader can readily observe the value of the method outlined since no tables are required and the accuracy even with a 6-inch slide is fully accurate enough for practical applications.

There are many who prefer to use trigonometrical methods to obtain vector resultants and although tables are required the methods are briefly given hereafter.

From Fig. 1 the basic relations are:

$$\sin \alpha = \frac{B}{C} \text{ or } C = \frac{B}{\sin \alpha} \qquad (7)$$

$$\cos \alpha = \frac{A}{C} \text{ or } C = \frac{A}{\cos \alpha} \qquad (8)$$

$$\tan \alpha = \frac{B}{A} \qquad (8)$$

We are usually interested in the values of A the in-phase or watt component and B the quadrature or var component. It follows then with values of A and B available we obtain as per formula (9) the value of $\tan \alpha$. This can be obtained by placing "A" on sliding scale C over "B" on the scale D; we then find the value of $\sin \alpha$ corresponding to $\tan \alpha$ from a table and place the value of $\sin \alpha$ over B on the D scale and read under one (1) at the end of sliding scale "C" the value of the resultant. A similar process can be followed using formula (8) and the A value and the $\cos \alpha$ value corresponding to $\tan \alpha$.

For example given A as 480 and B as 360 we find from formula (9). $\tan \alpha = \frac{360}{480}$ or 0.75, the $\sin \alpha$ corresponding tan 0.75 is from table 0.60 It then follows $C = \frac{360}{0.60}$ or 600. From formula (8) we get the $\cos \alpha$ value from the table corresponding to $\tan \alpha = 0.75$ and find it to be 0.7997 or say 0.8; then $C = \frac{480}{0.8}$ or 600 as before.

There is nothing new in any of the foregoing but reiteration seems in order as a "refresher" or reminder by drawing attention again to available methods.

INSPECTION OF TRANSFORMERS AND OIL CIRCUIT BREAKERS

THE INSPECTION of an oil insulated transformer that is in operation is necessarily confined to observing and noting the oil level, the temperatures as indicated by the gage, noting at the same time both the air or ambient temperature, and load conditions.

If, for any reason, the condition of the oil is open to suspicion between the more detailed shut-down inspections, samples should be drawn and tested in line with procedure outlined in manufacturer's instruction book.

Any unusual noise should be noted for a more detailed investigation during a shut-down period.

In the case of water-cooled transformers, the rate of flow should be checked from time to time. If found to have diminished, the cause should be looked for and remedied.

Circuit Breakers

The main points to be observed in the inspection of an oil circuit breaker are—

(1) Condition of the oil
(2) Condition of contact, both main and auxiliary
(3) Checking the operating mechanism to make sure it works freely yet is positive in closing, latching and tripping

The inspector should—while observing their condition—lubricate pins and bushings subject to wear—see that all cotters are in place—and that all bolts, nuts and screws having to do with the breaker structure are set tight.

Note carefully any evidence of heating—wipe off all breaker bushings, and check for cracked bushings.

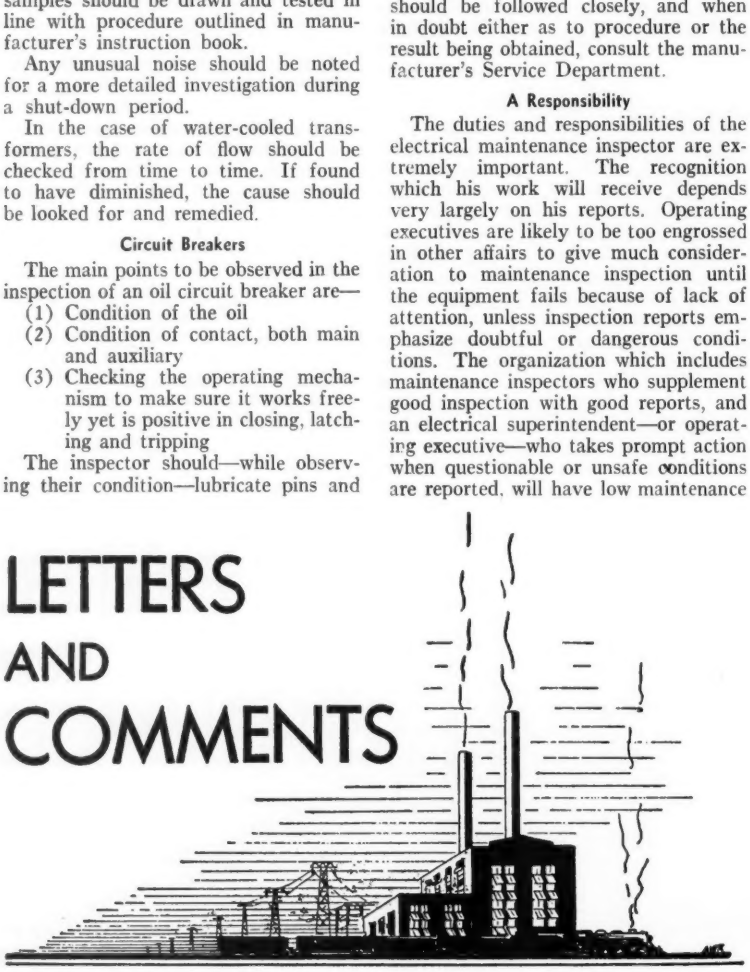
The same general points should be observed in going over the operating mechanism of an air breaker, whether electrically or manually operated.

In the adjusting or fitting of contacts, the manufacturer's instruction book should be followed closely, and when in doubt either as to procedure or the result being obtained, consult the manufacturer's Service Department.

A Responsibility

The duties and responsibilities of the electrical maintenance inspector are extremely important. The recognition which his work will receive depends very largely on his reports. Operating executives are likely to be too engrossed in other affairs to give much consideration to maintenance inspection until the equipment fails because of lack of attention, unless inspection reports emphasize doubtful or dangerous conditions. The organization which includes maintenance inspectors who supplement good inspection with good reports, and an electrical superintendent—or operating executive—who takes prompt action when questionable or unsafe conditions are reported, will have low maintenance

LETTERS AND COMMENTS



POWER HOUSE ERRORS

AFTER HAVING read the article of H. B. McDermid on "Power House Errors" thought that I could add something along the same line.

Here are a few observations relative to the above subject. Having made a visit recently to a local hospital (where I was asked to look around) I am going to report some of what I observed.

The first thing that was noticeable was the condition of the boiler room and its equipment, the boiler-room was dirty and the equipment was in poor operating condition. The operation of the boilers was very poorly conducted. There are four boilers and they are fired by oil (steam-atomized); the chimney was of sufficient size and height, but still the operators let the boilers smoke until the Chief went over to a couple of the burners and corrected the condition. Enough can't be said about the poor condition of the boilers and their maintenance. Each boiler had oil meters but none were in operating condition; neither were the steam lines leading to the burners. This steam line was hooked-up in such a manner that should one of the branch lines spring a leak it meant shutting down the entire burner system.

The boiler fronts showed many open spaces into the furnace, a condition causing unnecessary air leakage. There could have been installed a steam trap of the high pressure type for the main steam line to the burners.

As for the oil pumps one was steam-driven and the other was motor-driven. At this writing the steam unit isn't operating and if for any reason there is a power shutdown—even temporarily—it means that the power plant will not be able to supply heat. The boilers are not putting out even their rated capacity. (When the Chief who is now here took over he certainly had it put in his lap.)

The oil pump as well as the oil lines around the pump (motor-driven) leaked and this constituted a fire hazard.

The steam lines, valves, packing nuts on valves, flanges and other means of steam transmission showed signs of considerable leakage; one line that was blowing steam to the floor, then to the drain and then to the sewer could have been trapped back to the heater. Then there was the return line from the laundry; this exhaust from the laundry equipment came back direct with no trap in the line and when the feedwater in the heater got too hot it meant adding cold water to reduce the temperature as well as sending the treated water down the sewer.

I know the Chief and if he could get a free hand to do what he knows needs to be done, what a big change there would be in the next six months! By next winter the front office wouldn't believe there could have been such a huge reduction in the cost of operation. The money won't be spent so that is probably the big reason for the laxity but it still makes it hard for a Chief to get the work done the way he would like to do it. I have also noticed that in the past month the employment situation is beginning to tighten up and it will mean any engineer, operator or fireman who doesn't care to carry his share of the load while on watch will mean he is signing his own release from employment.

If only the men keep the place in clean, workmanlike manner it will show that they would like to keep the power plant and its equipment in good running order. And in this way it gives the Chief Engineer a means where he can go to the front office and get the material and also an O.K. to plan for future modernization of his entire plant and personnel.

So to sum it all up, I suppose that the condition of this plant covers the question fully and shows that there is neglect, carelessness, and poor management. The first two can be blamed on the last Chief and the operating engineers, the last on the front office for poor management. Why some so-called Chief engineers are hired without a check-up into their past employment is more than I can understand.

T. F. CUNNINGHAM..

B. F. PUMP BEARING TROUBLE OVERCOME

THE SUCCESSFUL operation of high speed centrifugal boiler feed pumps depends on good bearings and particularly on bearings that give trouble-free operation. Today the trend is for manufac-

turers to equip their pumps with various combinations of anti-friction bearings. On several occasions I have known this type of bearing to be short lived and troublesome and quite expensive due to replacements and shut downs especially when used for boiler-feed service and handling hot water at say 225 F temperature.

Since we have been supccessful in overcoming the difficulty mentioned above—we feel the information should be passed along in hopes it will help some other power plant engineer. In this case we refer to a two-stage boiler-feed unit which is motor driven and running at a speed of 3450 rpm with a capacity of 425 gpm and a head of 500 ft and handling water at 225 F.

Naturally at first sign of trouble the lubricant was blamed and resulted in the trying of different grades and brands of lubricant and at all times using reputable company's recommendations. We wish to mention here that these bearings were not water jacketed. This experimenting seemed of no avail as it was very common for a set of bearings to run, say two weeks, when they would start getting noisy and soon would get so bad that the unit had to be shut down and a new set installed.

In assembling these bearing sets on the pump shaft it was noted that the inner bearing race fitted quite snug on the shaft and of course had to be pressed on. This fit was probably according to manufacturers recommended clearances. The most important item to be considered is what hapens when the pump is put into operation and the shaft temperature is raised say 200 F or more. Naturally the shaft diameter becames larger due to this rise in temperature which in turn stretched this inner race and thereby reduced the running clearance of the bearing balls causing a preloaded condition. To test this theory—the shaft diameter was reduced by the hand application of emery cloth and oil to a point where the bearing set could be placed on the shaft by hand or by a very light pressure. This was the answer—for instead of a bearing life of two weeks, it is now two years or more. In fact when the impellers and rings become worn to a point of repair—the bearings are removed and replaced on the spare shaft and runner assembly for further service.

Our lubrication of this unit is no problem and lubricant selection is not so important except that it should be the best grade obtainable from some reputable company. Since this is the grease packed type, the bearings are packed by hand at time of installation and no more grease is added at any time since it is so easy to add an excess which would cause a hot running bearing. Instead—about an ounce of SAE 30 or 40 motor oil is added say once a week through the grease cup connection, but never any grease. This practice has worked for us and it should work for others.

U. J. GRANT

PLUGS AIN'T ALWAYS PLUGS

WHERE I work there are two HRT boilers of 1909 vintage supplying steam to two generators of 23 and 50 kva. Recently the boilers were retubed with the ends being welded in one tube sheet. The boilermakers—young men by the way—removed the old fusible plugs which were of the correct outside style. In their place they put two inside style, locomotive type plugs.

I believe the chief engineer pointed out to the workmen the difference between the two types of plugs. Their answer was "plugs are plugs, there ain't no difference."

About three weeks ago one of the boilers (No. 2) was down for repairs. The chief decided, while he had a chance, to remove the plug the boilermakers had put it. In its stead he put an outside type—one he had hidden away somewhere.

I happened to be on watch a few days ago on the day shift. One of the duties of the day shift man is to test the water. I had blown down both water columns and noticed I had the correct water level showing in the glasses.

I was in the engine room testing the water samples when I heard the fusible plug on No. 1 boiler blowing.

I dumped and doused the fire and was pretty busy for the next half hour or so changing over to outside power and shutting down our own generators. All this on what would have been an otherwise quiet Sunday morning. If it had happened on the night shift it would look as if someone had fallen asleep and let the water go low.

When the chief came it appeared as is he was half expecting such a thing to happen. He showed me the plug he had removed some time previously from the other boiler. Comparing it with an old plug he pointed out to me the difference between the heat-absorbing surface of the water side and the side exposed to hot gases. The chief lost no time phoning the boilermakers. In a day or so they sent down six correct type plugs with the explanation they could not get them all along.

This was a case of the young boilermakers "knowing it all" and the "old fogey" the chief, " he don't know nothing."

Experience cannot be brushed aside lightly. The chief could not insist on proper plugs as the front office had sent word not to interfere with the contractors.

W. J. HARDING

Questions And Answers

Question No. 368

WHAT IS BEST CLEANING MATERIAL FOR FREON-12 CONDENSER?

WHICH of the following fluids should I use to clean a Freon-12 shell-and-tube condenser: water, Freon-12, ammonia, carbon dioxide, sal soda or carbon tetrachloride?

Ridgewood, Brooklyn, N.Y. H.B.

Question No. 369

HOW DESIGN DUTCH OVEN FOR WOOD BURNING HRT BOILER?

I HAVE BEEN reading the Boiler Fireman's Handbook and other books on power plant work, but do not find too much definite information on Dutch ovens for wood-burning furnaces.

I recently took a job in a plant where one of the boilers is an HRT 250-hp, 150-psi boiler, equipped with a Dutch oven for burning sawdust, wood shavings and refuse. The boiler is 84 in. in diameter, 18 ft long with 114 tubes of 4-in. diameter each.

I would like to know what the proper dimensions should be for a Dutch oven for this boiler and approximately what the flue gas temperature at the boiler exit should be when burning this wood fuel at the best efficiency.

St. Louis, Mo. E.F.B.

Editor's Note—For data on representative wood fuels and excess air, and for efficiency calculations, see *Boiler Fireman's Handbook*, Chapter VII, February 1945. Apparently E.F.B. also overlooked Chapter XXI, May, 1946 issue of the *Handbook*. This gives data on how to calculate Dutch ovens for wood fuel.

Good data on furnace volumes for wood burning are also given in Boiler Settings for Burning Refuse Wood by C. S. Gladden, *Transactions ASME*, January to April, 1931.

Square feet of heating surface for the above boiler can be figured by the standard method given in the ASME Boiler Code.

Question No. 370

HOW DEFINE PER CENT OF BLOWDOWN?

PLEASE TELL me the correct definition of the term "per cent of blowdown."

Should this be defined as (Pounds blowdown ÷ Pounds total boiler steam flow) × 100 = Per cent blowdown?

Or should it be (Pounds blowdown ÷ Pounds Feedwater flow) × 100 = Per cent blowdown?

San Diego, Calif. D.R.

Question No. 371

HOW CALCULATE JOINT EFFICIENCY?

RECENTLY a discussion arose in our boiler room about the correct solution

of the following problem given on an examination. Would Q & A readers kindly show how this calculation is made?

Find the efficiency of a double-riveted, butt strap joint in which t = ½ in.; TS = 60,000 lb; rivets are ⅞-in.; rivet pitch 2¾ in.

New York E.W.G.

Answer No. 349

HOW TELL WHETHER COAL OR OIL IS CHEAPER TO BURN?

Oil Has Many Operating Advantages, Says Mullen

IT IS as H.G.C. says: different conditions can be found in different plants. With poor operation or lack of proper devices or equipment in either an oil plant or a coal-fired plant, there will be no saving.

In a coal-fired plant where the Chief knows his business and has the proper equipment, along with the good operators, then such a power plant will show a saving as compared with oil burners.

But take a chief the same as above, who has the same conditions as the coal-fired plant, he will operate per thousand pounds of steam much cheaper.

The following are the advantages of oil over coal.

1. Weight 30 per cent less and space occupied 50 per cent less than coal of equivalent heat content.
2. No deterioration in storage.
3. Freedom from spontaneous combustion.
4. Storage may be distant from furnaces.
5. Fuel is immediately available and may be stored or removed with minimum labor.
6. High combustion rates per cubic foot of combustion space.
7. Great flexibility in furnaces to readily and economically carry fluctuating loads.
8. Low labor cost to handle oil at the furnace and to clean boiler tubes.
9. No labor for cleaning fires or removing ash.
10. High efficiency and practically no smoke.
11. Absence of wear on machinery due to ash and dust.
12. Low pressure drop through the furnace.
13. A minimum of excess air required for complete combustion.

As H.G.C. says, the cost is practically the same but what isn't figured on is the efficiency of these two, when all operating conditions are taken into consideration. All H.G.C. has to do is to take two plants, one coal and one oil-fired, and then look at the advantages of oil (13 in all, maybe some operators can add one or more).

Philadelphia 43, Pa. WM. T. MULLEN

Answer No. 350

WHY DO HIS AUTOMATIC STOP VALVES CHATTER?

Drilling Holes Destroys Dashpot Action, Says Mullen

IT SEEMS ODD that the both automatic stop valves should act this way; one acting in this manner might be expected sometime, but for both to act in the same way is not a coincidence.

Keeping the steam pressure right where it is supposed to be is good, provided both boilers are doing the same amount of work. Often one boiler carries the load while the other one lags and if the boiler that lags doesn't keep the steam pressure up to the header pressure then the valve will close. It may be that the boiler that lags in maintaining the pressure falls a couple of pounds below the header pressure or that the steam pressure gage is out a few pounds and this is the reason for the automatic stop valve opening and closing so often that the dash-pot doesn't function properly.

Where C.G.C. has made a mistake is in drilling holes in the pistons of the automatic valves. These pistons were the dashpots. Such pistons were made to cushion the valve and when the valve disk is not restrained then it will chatter and hammer and thus be destroyed by this action. This is just what happened to these valves.

Screwing down on the piston with the valve stem closes the stop valve and if this was done and the steam pressure carried, it didn't take long for the safety valves to blow.

What now can be done is to shut one boiler down at a time, remove the automatic valve, making sure to close the header stop valve so no steam can flow back to the dead boiler. Check the valve disc, also the valve seat and the dashpot, make sure that these are all good before putting them back together. If in doubt, the manufacturer will send a man to check this for you, and in this way a double check on the work done on the valve and its proper care will result in a good job.

Philadelphia 43, Pa.

WILLIAM T. MULLEN

Watch Boiler Water Level, Says Allen

If C.G.C. is having chatter in his stop valves when running his engine, he might try running his boilers with the feed pumps set so that there is not over 2 in. of water in the glass while the engine is operating. Do not let the water get high in the glass. Be sure that each boiler is getting the same amount of fuel so far as possible. I fired for a Corliss Engine 12 years.

Rock Falls, Ill. MASON L. ALLEN

Analysis by Stuthers

TO SUGGEST to C.G.C. the exact remedy to overcome chattering and ruination of his automatic stop valves is easy; but to advise him just where to apply the remedy poses a problem. He seems to have a wire-drawing steam condition.

C.G.C. does not indicate whether the chattering has existed since the plant was built or whether additional steam loads have since been installed without increasing the steam header or outlet piping from the boilers; nor whether the chattering action increases or decreases under varying operating load conditions.

This chattering no doubt results from pulsation, which in itself can be most nerve wracking and can become dangerous, since the interior parts of the valves may eventually disintegrate and cause other troubles more serious, not to forget vibration troubles which accompany such action.

There is no doubt that C.G.C.'s trouble is nothing more than incomplete steam volume supply; maintaining pin point boiler gage pressure will help to hold chattering to a minimum but partially closing the valves by screwing down on the valve stems only adds trouble by decreasing the volume of steam flow.

Conditions might temporarily be improved or fully cured by removal of the pistons in the valves, eliminating their automatic action. But what is really needed is a larger dry steam flow to his engines by removal of restrictions in the piping, cleaner or larger separators or possibly a larger diameter steam supply pipe, a larger steam header or steam accumulator close to each engine.

If chattering persists with all steam piping shut off other than the supply to the engines, there should be very little doubt that dry steam flow is restricted. On the other hand, if chattering occurs or increases on opening of additional steam supply valves, it will indicate that the engine sare being robbed and that elimination of volume restrictions is the remedy required.

Pittsburgh 16, Pa. J. W. STUTHERS

WHY DOES HE HAVE TO ROLL TUBES OFTENER?

W.J.H. is Having Same Trouble as L.L.C.; Needs the Answer, Too

I AM MUCH interested in Question 351 in the November issue. Strangely enough, we are having the same troubles with leaking tubes that L.L.C. is experiencing. While we do not have the load fluctuation too much, we do have extremes in the feedwater temperature entering the boilers.

The trouble with the tubes got so bad it was decided to retube the boilers. This was done last summer, the tubes being welded on the rear tube-sheet, with the Boiler Inspector's approval.

After a few weeks run, the cleaning brushes were coming out of the tubes with a thick gum-like substance on them. Somebody started off by saying it was caused by the new boiler compound we were using. The compound salesman said it was caused by leaking tubes. The company that welded in the tubes put a test on the boiler and found no leaks. The Boiler Inspector expressed the opinion the trouble was caused by the gas constituents in the coal we are using. He advised cleaning the tubes when the boiler was good and hot. The trouble persists, however, at times.

A long spoon was rigged up and reached into one of the tubes and a sample of this wet substance taken and analyzed by the compound salesman. He has come up now with the answer that it is linseed oil the tubes must

have been covered with while in storage, before being put into the boilers.

We will get the correct answer, I assume, in the answers to L.L.C.'s problem.

Morristown, N.J. W.J.H.

Keep Free of Scale, Roll Properly, Warm Up Slowly

THE FIRST THING to make sure of is: does the fireman heat the boilers too fast when starting them up. Since the boiler tubes expand first, more boiler tubes are loosened from the starting up, not after the boiler has been on the line.

2. After the tubes start to leak they become worse and worse.

3. I might say that the trouble is all on the tubes in the rear end where the flame may hit them.

4. I would say they don't have leaks on tubes in front plate of boilers.

5. If they are using reciprocating steam-driven boilers, they are getting too much steam cylinder oil in their boiler feedwater which will cling to ends of tubes and cause them to leak.

6. If tubes have very much scale on rear head they will heat and leak.

7. I do not believe in welding tubes in boiler.

8. If your boilers are free from scale and the tubes are rolled by experienced men, then see that boilers are warmed up slow.

I have had 17 yrs of boiler experience. I have rolled many 3 and 4-in. tubes, taking them out and replacing tubes, caulking rivets and seams.

Rock Falls, Illinois M. L. ALLEN

Scale on Rear Heads May Be the Cause

THE TUBE trouble that L.L.C. is experiencing can, I think, be traced to an accumulation of scale on the back heads of his boilers. His statement that at times the chlorides have run somewhat higher than recommended lead me to believe that he has scale in in his boilers. A formation of scale on the back heads would cause the tube ends to become overheated when the boilers were being operated at high ratings and naturally loosen them where they are expanded into the head.

I suggest that L.L.C. construct a chisel out of ¼ or 5/16-in. round iron rod, with a point or blade that will readily pass between the tubes. It should be long enough to reach the lower rows of tubes when working from above the tubes in the boiler. Using this chisel on the back head between the tubes both vertically and horizontally, the scale can all be removed. It will of course, necessitate considerable hot and disagreeable work; but with enough stick-to-it-iveness it can be accomplished well.

After the head has been cleaned, all tubes that show signs of having leaked should be expanded or rolled and providing the tube ends are not burned there should be no recurrence of the trouble if the head is kept free of scale.

Regarding the welding of the tubes to the boiler plate, I have this to say. This should never be done without first obtaining the permission of the insurance company carrying the boilers; and then only under the strict supervision of a representative of this company who is thoroughly versed in this procedure.

Duluth, Minn. E. R. WEBBER

Answer No. 358

HOW MUCH CHLORINE FOR SWIMMING POOL WATER?

THE "MOSS" got ahead of him, said G.B. in the January issue, after he took charge of the operation and maintenance of a swimming pool last fall. The pool has a capacity of 6700 cu ft, the equipment includes a sand filter, pump, heater, chlorinator and all the necessary equipment. How should he adjust his chlorine feed to kill this algae and keep it under control? asked G.B. Also, should he use blue vitriol in conjunction with the chlorine?

In general, the procedure necessary to control algae—the "moss" G.B. refers to—in such pools as the above depends on the characteristics of the water and the way in which the water treatment equipment is operated. It has been found in many cases that proper treatment with chlorine alone will prevent the formation of algae and that is the best to use. Where waters are high in alkalinity, as they may be in G.B.'s case, treatment with copper sulfate often results in the formation of copper compounds in the water that have no effect whatever on the algae.

Furthermore, in such cases, overdosing with copper sulfate may have disadvantages by producing such a high concentration of copper compounds in the water that it will affect the color of hair of swimmers or the color of swimming suits. On the other hand, proper dosage with copper sulfate helps to eliminate ammonia from the water.

To use chlorination in killing or preventing algae, it is necessary, says circular No. 125 of the Illinois Department of Public Health, first to feed chlorine to the pool water at a rate of about 10.0 ppm when no swimmers are in the pool, for example, at night. This produces what is known as superchlorination. The object of it is to obtain a free chlorine residual throughout the pool water of about 2.0 ppm. Then recirculate that water until the free chlorine residual drops below 1.0 ppm before allowing swimmers into pool.

For general purposes, the chlorine feed should be adjusted to maintain approximately 0.5 ppm free chlorine residual in all parts of the pool water. The chlorine feed should preferably be continuous.

For keeping down ammonia and also for eliminating algae, copper sulfate, which G. B. refers to as blue vitriol, can be used. It can be fed in solution into the pump suction line in proportion of about 1.5 to 2.0 ppm. Also, bags of copper sulfate crystals are often dragged through the pool water. When this method is used, the initial dose is usually about 20 lb per million gallons.

Treated algae clinging to bottom and sides of pool must be brushed loose with weighted brushes. It may then be removed by the suction cleaner and filtration system.

An additional remedy is to scrub the pool walls and bottom with a 5 per cent solution of copper sulfate when the pool is emptied for cleaning.

In order to determine exactly how much of these chemicals are required, not only to kill the algae but also to maintain the water in proper sanitary condition, samples taken from various points in the pool, and also from the pool inlet and outlet, must be tested. This is usually done with a chlorine comparator and pH test kit which is available from various manufacturers. They are often sold for $25 or $30 in special kits containing all the necessary test equipment and proper instructions for using. Tests for free chlorine residual should be made twice daily and tests for pH should be made daily.

It is important to maintain the pH of the pool water at from 7.2 to 7.6. This value results in more effective elimination. The alum, usually used as a coagulant for suspended matter to aid in filter operation, tends to lower the pH of the pool water depending on the alum dosage and the alkalinity of the water. This alum is frequently fed into the pump suction line in modern installations, although formerly it was often added through a venturi tube on the filter manifold.

Alum should be added only after filter washing and in a small amount, not continuously—usually two to three quarts dry measure. This will last from one filter wash to the next.

To counteract overdosage of alum, soda ash in solution is often fed into the filter influent or the pump suction line by means of a solution pot or positive feeder. In other cases it may be introduced into the water by throwing briquettes of soda ash into the pool.

Full details of tests to be made, proper way of taking water samples, methods of connecting and operating equipment and feeding chemicals and all other necessary data are given in Educational Health Circular No. 125, published by the Division of Sanitary Engineering, Department of Public Health, State of Illinois, Springfield, Illinois.

Most states have a Department of Health which will gladly co-operate with the operator of any swimming pool, help him with information on how to take samples and test them himself, and in some cases offer a testing service including bacteriological examination. G.B. should, of course, consult the Department of Health in his state for these purposes and if necessary, should also request information from the manufacturers of his chlorinator and filtering equipment on the proper way to operate.

Comments from readers will be welcomed. See also the answers to Question No. 322, page 106, July issue.

QUICK REFERENCE TABLES OF CONVERSION FACTORS

Courtesy WESCO REPORTER
Westinghouse Electric Supply Co.

CONVERSION FACTORS

To Convert	Multiply By
AREA	
Circular Mils to Square Inches	.0000007854
Circular Mils to Square Mils	.7854
Circular Mils to Square Millimeters	.0005066
Square Centimeters to Square Inches	.155
Square Feet to Square Meters	.0929
Square Inches to Circular Mils	1,273,200
Square Inches to Square Centimeters	6.4516
Square Inches to Square Millimeters	645.16
Square Inches to Square Mils	1,000,000
Square Meters to Square Feet	10.764
Square Millimeters to Square Inches	.00155
Square Millimeters to Circular Mils	1,973.51
Square Mils to Circular Mils	1.2732
Square Mils to Square Inches	.000001
LENGTH	
Centimeters to Inches	.3937
Centimeters to Feet	.03281
Feet to Centimeters	30.48
Feet to Meters	.3048
Inches to Centimeters	2.54
Inches to Meters	.0254
Inches to Millimeters	25.4
Inches to Mils	1,000.
Kilometers to Miles	.6214
Meters to Feet	3.2808
Meters to Inches	39.3701
Meters to Yards	1.0936
Miles to Kilometers	1.6093
Millimeters to Inches	.03937
Millimeters to Mils	39.3701
Mils to Inches	.001
Mils to Millimeters	.0254
Yards to Meters	.9144
POWER	
Foot Pounds per Minute to Horsepower	.0000303
Foot Pounds per Minute to Watts	.0226
Foot Pounds per Second to Horsepower	.001818
Foot Pounds per Second to Watts	1.356
Horsepower to Foot Pounds per Minute	33,000
Horsepower to Foot Pounds per Second	550
Horsepower to Watts	746
Kilogram Meters per Second to Watts	9.807
Watts to Foot Pounds per Minute	44.25
Watts to Foot Pounds per Second	.7375
Watts to Horsepower	.001341
Watts to Kilogram-meters per Second	.1020
ENERGY	
British Thermal Units to Foot Pounds	778
British Thermal Units to Joules	1,055.
British Thermal Units to Watthours	.293
Foot Pounds to British Thermal Units	.001285
Foot Pounds to Joules	1.356
Foot Pounds to Kilogram-meters	.1383
Gram Calories to Joules	4.186
Joules to British Thermal Units	.000947
Joules to Foot Pounds	.7375
Joules to Gram-Calories	.2388
Joules to Kilogram-meters	.10198
Kilogram-meters to Foot Pounds	7.233
Kilogram-meters to Joules	9.8117
Watthours to British Thermal Units	3.4126
MISCELLANEOUS	
Kilograms to Pounds	2.205
Kilograms per Kilometer to Pounds per 1000 Feet	.6719
Ohms per Kilometer to Ohms per 1000 Feet	.3048
Ohms per 1000 Feet to Ohms per Kilometer	3.2808
Ohms per 1000 Yards to Ohms per Kilometer	1.0936
Pounds to Kilograms	.4536
Pounds per 1000 Feet to Kilograms per Kilometer	1.488
Pounds per 1000 Yards to Kilograms per Kilometer	.4960
Pounds per 1000 Yards to Pounds per Kilometer	1.0936

WEIGHTS OF MATERIALS

Liquids

	SPEC. GRAV.	LB./GAL.		SPEC. GRAV.	LB./GAL.
Acetone	.79	6.6	Kerosene	.80	6.7
Amyl Acetate	.88	7.3	Lard Oil	.92	7.7
Benzine	.77	6.4	Linseed Oil	.94	7.8
Benzol	.89	7.4	Machine Oil—Naphtha, Heavy	.90	7.5
Butyl Alcohol	.81	6.8		.94	7.8
Butyl Acetate	.88	7.3	Paints, Flat	1.26	10.5
Butyl Cellulose	.90	7.5	Paints, Gloss	1.62	13.5
Carbon Tetrachl.	1.60	13.3	Shellac	.90	7.5
Castor Oil	.97	8.1	Sodium Silicate	1.44	12.0
Chinese Wood Oil	.94	7.8	Varnishes—Ins.	.84	7.0
Glue Liquid	1.28	10.7	Water	1.00	8.34
Inerteen	1.55	12.9	Wemco Oil	.94	7.5
			Xylol	.86	7.2

Metals

	SPEC. GRAV.	MELT. PT. °C	MELT. PT. °F	LB./CU.IN.		SPEC. GRAV.	MELT. PT. °C	MELT. PT. °F	LB./CU.IN.
Aluminum	2.71	658	1217	.0975	Lead	11.4	327	621	.411
Antimony	6.71	630	1166	.242	Magnesium	1.74	651	1204	.0629
Bismuth	9.80	271	520	.354	Manganese	8.0	1225	2237	.289
Brass	8.51	....	....	.307	Mercury	13.6	-38.7	-37.7	.491
Bronze, Phos.	8.7	....	....	.314	Monel Metal	8.87	....	....	.320
Cadmium	8.60	321	610	.311	Nickel	8.80	1452	2646	.318
Calcium	1.57	810	1490	.0567	Platinum	21.5	1755	3191	.777
Chromium	6.80	1510	2750	.246	Silicon	2.42	1420	2588	.0874
Cobalt	8.50	1490	2714	.307	Silver	10.5	961	1761	.380
Copper Rolled	8.89	1083	1982	.321	Steel	7.86	1330 to 1380	2370 to 2520	.284
Copper Tubing	8.95	....	....	.323	Tin	7.29	232	450	.263
Gold	19.3	1063	1945	.698	Tungsten	19.1	3000	5432	.690
Iron, Cast	7.2	1200 to 1400	2190 to 2550	.260	Vanadium	5.50	1730	3146	.199
					Zinc	7.19	419	786	.260
Iron, Wrought	7.70	1500 to 1600	2730 to 2910	.278					

Tailor-Made Industrial Oil Firing

By **R. J. BENDER,** Assistant to Chief Consulting Engineer, Sinclair Refining Co., New York

Success of oil firing in large and medium-sized power plant boilers depends on many factors, which must be considered before deciding on type of burner . . . Steam atomizing burners atomize almost any liquid fuel . . . Mechanical atomizing burners require proper oil heating . . . How to handle wide load range with mechanical atomizing burner . . . Rotary-cup burners popular in packaged units . . . Combination burners for firing two fuels simultaneously or separately . . . Combustion chamber design important . . . Slag deposits influence design of boiler and superheater

ONE OF THE remarkable features of the Power Show held last December in New York was the great number of automatic oil-fired packaged boiler-units exhibited. There is definite evidence that automatic oil firing, besides the extraordinary popularity for domestic heating, is making steady progress in what might be termed the semi-industrial field.

Surveys conducted by several reliable organizations have shown recently that

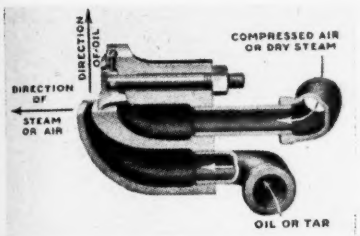
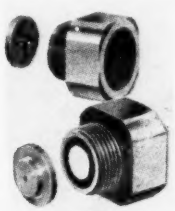


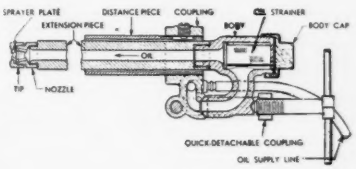
Fig. 1. Cross-section of a high-pressure steam-atomizing oil or tar burner

the great majority of boilers in operation and on order in the Eastern States and the Great Lakes region consists of small boilers, with steam production below 10,000 lb per hr each. An ever increasing number of manufacturers are devoting their efforts to that field, for which the packaged, automatic, oil-fired units seems quite indicated and has been eminently successful.

It should be understood, however, that for steam production on a larger scale, up to figures of millions of pounds per hour, the success of oil firing depends chiefly on the proper tailor-made design of the installation, with perfect coordination between the boiler maker, the burner manufacturer, the oil supplier and the operator.

Fig. 4. Right—Mechanical - atomizing oil burner





Consider These Factors in Burning Oil

Careful consideration must be given by all of these to such questions as:

1—Nature of the load, steady or variable
2—Space available for the unit and its auxiliaries
3—Pressure and temperature of the steam and degree of importance of its steady quality
4—Advisability of using preheated air
5—Amount of water cooling in the furnace
6—Grade of fuel oil available, now and in the future
7—Size and type of oil storage equipment
8—Design of the oil preheating and handling equipment
9—Air supply and exhaust gas dispersion
10—Automatic controls and recording instruments
11—Finally—type of oil burner

All other considerations were purposely listed before the selection of the oil burner to emphasize that all, to a greater or lesser degree, and not necessarily in the order indicated, have their bearing upon the type, the size, the number, the location of the oil burners, a fact which is sometimes ignored with regrettable consequences.

Oil burner design has progressed to the point where the proper burner for the job can be selected with a minimum of uncertainty.

Industrial oil burners can be classified in three distinct categories.

Steam Atomizing Oil Burners

Steam-atomizing oil burners are among the oldest in existence and also the simplest. They are indicated only when large quantities of inexpensive steam are available. Almost any liquid fuel can be atomized with steam, regardless of its original viscosity or tempera-

Fig. 3A. Steam or air-atomizing burner

Fig. 2. Below—Y-jet wide-range steam atomizing burner

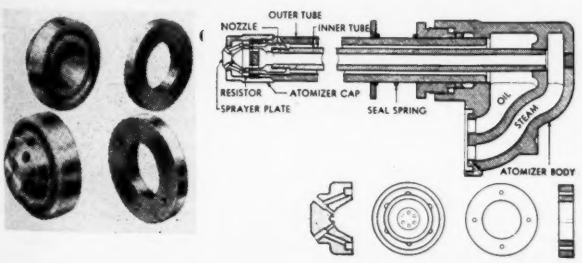
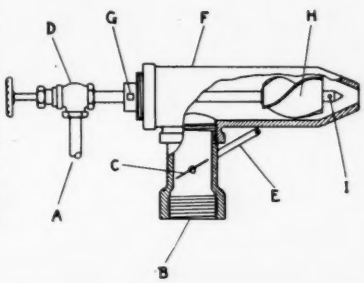


Fig. 3. Right—One type of industrial air-atomizing burner. A-oil pipe; B-air pipe; C-butterfly air gate; D-oil needle valve; E-butterfly control handle; F - burner body; G-set screw to immobilize whirling spiral H; I-atomizing cone



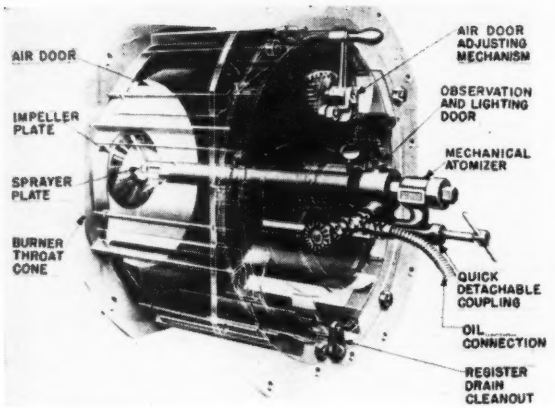
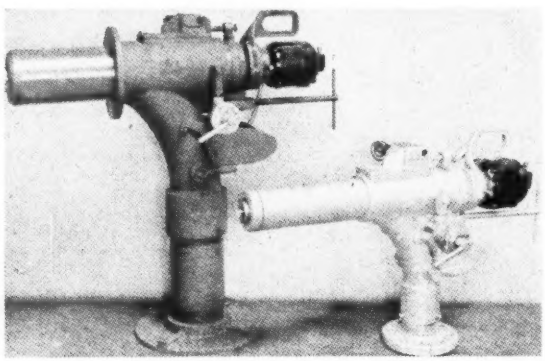
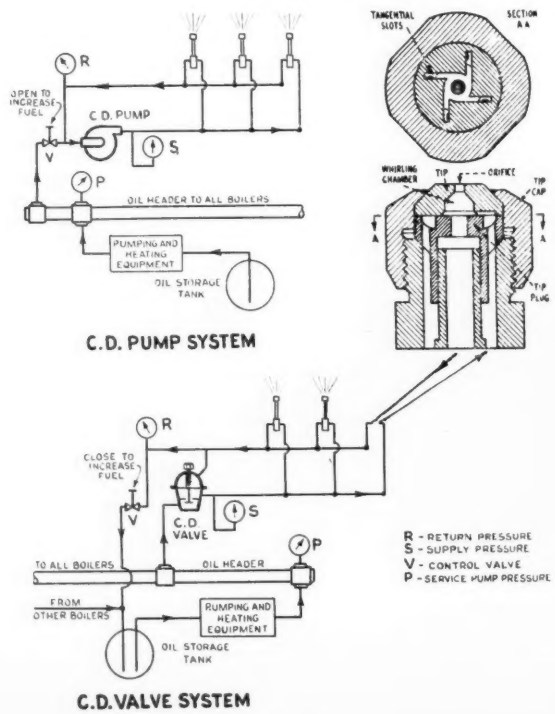


Fig. 5. Phantom view of mechanical atomizing burner complete with air register

Fig. 9. Right—Combination pulverized-coal and oil burner

Fig. 8. Below—The rotary cup burner, capacities of 1000 and 2000 lb oil per hr, without air register





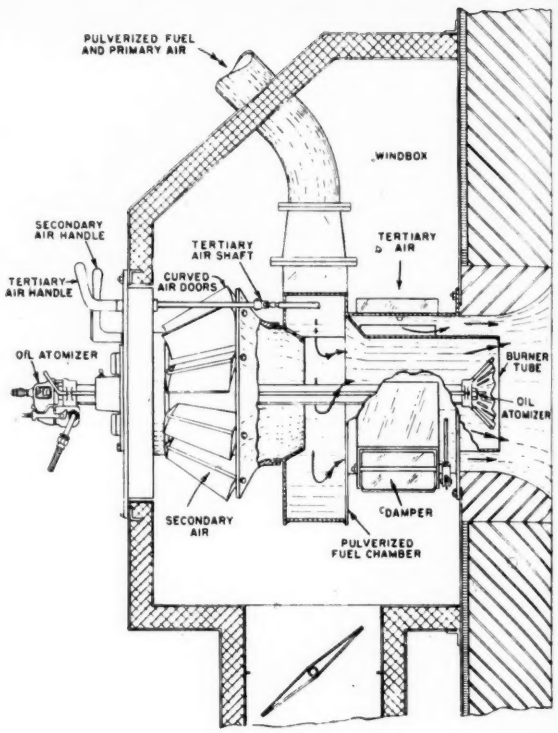


Fig. 10. Right—Diagram of temperature—viscosity control for a rotary-cup burner installation

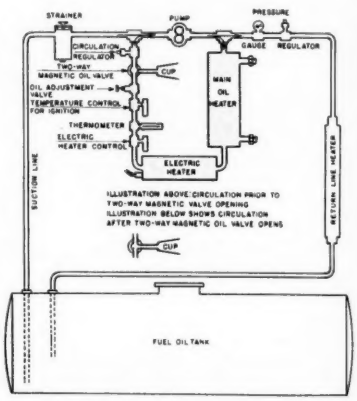
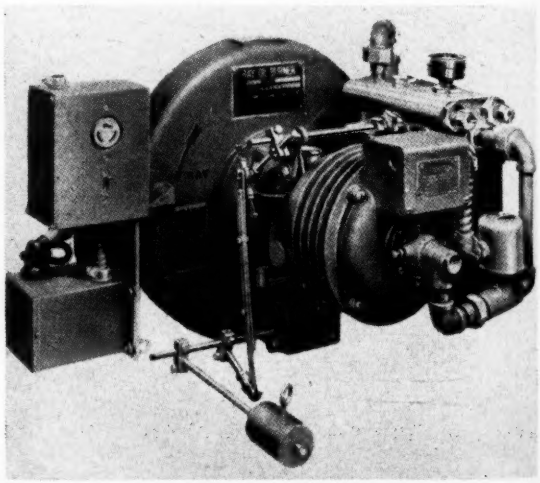


Fig. 6. Left—The C-D (constant-differential) wide-range mechanical atomizing burner, with either valve or differential pump

Fig. 7. Below—The fully-automatic cup burner



ture. The flame produced may be either conical, with almost any angle, or flat, such as may be desired to duplicate the shape of a solid fuel bed. Steam atomizing oil burners can be either of the premixing type or external-mixing burners, as illustrated in Fig. 1.

The steam consumption is estimated at figures ranging from 1 per cent to 5 per cent of the steam produced, average being probably around 2 per cent. Naturally the human element has an immediate bearing upon the steam consumption. Steam pressure required varies from 75 to 150 lb, and all the oil pressure necessary is that required to carry the fuel to the burner tip (10 to 15 lb). The particular type of steam atomizing burner illustrated in Fig. 2 with Y-jet multi-orifice sprayer, has a capacity of 5,600 lb of oil per hour; all the air necessary for combustion is admitted through the burner, not through hollow floors and walls as is done for secondary air in small installations.

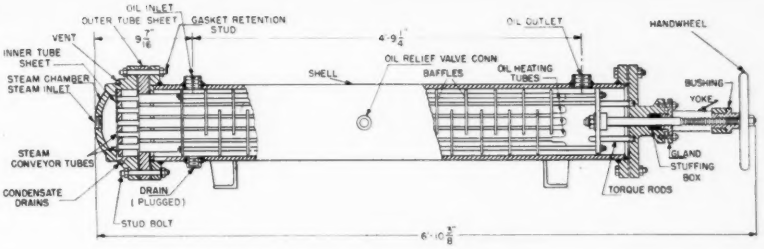


Fig. 11. A cleanable tubular oil heater

To maintain clean tube heating surface, turn handwheel approximately twice each 8 hours from inner stop position to outer stop position. End of cleaning operation should leave handwheel at the inner position as shown

Compressed air at 16 to 24 oz can be used instead of steam; this is applied mostly in the industrial field (metallurgy, heat-treating, ceramics) where comparatively small quantities of air and fuel are involved, in view of the high cost of compressed air. A burner of this type is shown in Fig. 3.

Mechanical Atomizing Oil Burners

Burners in which oil is atomized mechanically by being compressed at high pressure, then released through a small orifice, are among the most popular and widely used. Fig. 4 shows details of a burner of this type. The air necessary for combustion is admitted into the spray of oil at the proper pressure and in the right manner to insure good turbulence and rapid complete insulation. Fig. 5 shows how this is done.

Optimum operating conditions with mechanical atomizing burners require the oil to reach the burner tip at a viscosity of approximately 150 Saybolt Seconds. This calls for a preliminary heating of the oil to the temperature at which such a viscosity is obtained. That temperature may vary greatly with the nature of the fuel oil; for example it may be 160 F for one type of oil and 210 F for another. Great care should be exercised to avoid excessive heating and resulting poor atomization. Oil pressures in these burners vary from 150 lbs to 300 psi, optimum being between 225 and 300 psi.

One of the drawbacks of the conventional mechanical atomizing burners is that they are most efficient only for a narrow range of oil flow, let us say a range of not over 40 per cent of vari-

(Continued on page 144)

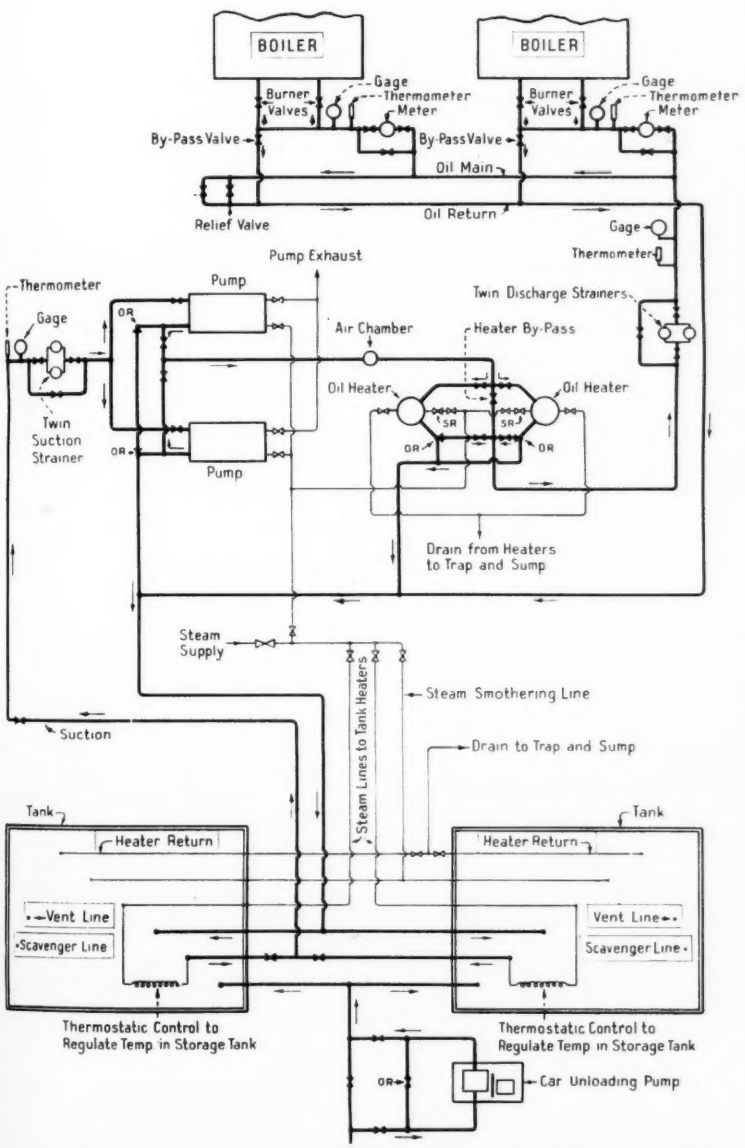


Fig. 12. Schematic diagram of an oil-burning system showing typical arrangement of fuel storage, pumping and heating equipment, with necessary gages, thermometers and heaters. OR = oil pressure relief valve; SR = steam pressure relief valve

Table of Specifications of heavy fuel oils

	CS 12-40 No. 5 Oil	CS 12-40 No. 6 Oil	7-0-1 Navy Special	7-0-1 Navy Grade II
API Gravity, Min.			10	10
Flash Point Open Cup, Min.	130 F	150 F		
Flash Point Closed Cup, Min.			150 F	150 F
Fire Point, Min.			200 F	220 F
Viscosity SSF @ 122 F, Max.	40	300	25	100
Viscosity SU @ 100 F, Min.	50			
Pour Point, Max.			15 F	50 F
Ash Content, Max.	0.10%		0.10%	0.12%
Water (By Distillation), Max.			0.5%	0.5%
Conradson Carbon, Max.			15%	
Sediment (By Extraction), Max.			0.12%	0.15%
Sediment (By Centrifuge), Max.	1%	2%	0.5%	

ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Nuclear Energy and Electric Power

Significance of slow nuclear reaction on the possible development of electric power . . . Basic principles of the self-sustaining nuclear reaction pile . . . Present plans for the development of atomic power plants . . . The Daniels pile at Oak Ridge, Tenn. . . . Idea of conversion of nuclear energy directly into electric power . . . Review of processes by which electric currents are ordinarily generated . . . Possible separation of electrons from atomic systems by the use nuclear energy . . . Possible use of Thermionic effect

By **ANDREW W. KRAMER** Managing Editor, Power Plant Engineering

IT IS RATHER CURIOUS that in the development of the atomic bomb, that is in our search for the explosive release of nuclear energy, we should first have attained a slow nuclear reaction—one capable of producing useful power. That, of course, is what nuclear research during the past 25 years had been aiming for—the development of nuclear power. It so happened during the war that what was needed most was an explosive reaction and all effort was bent in that direction. Yet in the process of attaining that explosive reaction, that is the atomic bomb, we first hit upon the slow nuclear reaction in the plutonium pile.

First Self-Sustaining Pile

As is well known now, the first self-sustaining nuclear reaction pile went into operation on December 2, 1942. This was the pile erected on the floor of a squash court under the west stands of Stagg Field at the University of Chicago. At the present time, college football is subject to a great deal of criticism and notoriety but intercollegiate football was abolished by the University of Chicago many years ago. This is rather significant because in the years to come the world will little remember or care which college football team won the Rose Bowl or Sugar Bowl games in 1942 or any other year. But it will never forget what took place under the stands of Stagg Field at the University of Chicago on December 2, 1942. That day will go down in history as one of the most important in the annals of mankind, for it was on that day that man first succeeded in harnessing the almost limitless power of the atom.

While the pile at the University of Chicago produced plutonium from U-238, its primary purpose was not the production of plutonium but to determine whether or not a self-sustaining nuclear reaction was possible. From the very first announcements of Hahn and Strassmann's discovery of uranium fission it was clear that the neutrons initiating fission of uranium reproduced themselves, and it seemed probable, therefore, that a multiplying chain reaction could be brought about. If such a chain reaction was to be of any use, it was evident that some means must be found to control it. As early as 1940, it seemed likely that by using neutron absorbers a chain reaction could be attained that could be controlled. The idea of employing a moderator material such as graphite to reduce non-fission captures had been developed, and this led to the idea of using a lattice structure such as was ultimately incorporated in the first University of Chicago pile. This pile [1] consisted of layers of graphite bricks, alternate ones of which contained lumps of uranium at the corners of the squares. Neutrons released by the fission of U-235 in the lumps of uranium traveled through the graphite and were thus slowed down to a speed which was effective in producing fission of other U-235 atoms in adjacent lumps of uranium. It must be remembered that fission of uranium 235 is produced most effectively by neutrons moving at relatively slow speeds. It was therefore necessary to slow neutrons down by means of the moderator. Neutrons also converted U-238 nuclei into plutonium as described in previous articles.[2] To control the chain reaction in the pile cadmium safety rods were built into the pile, arranged in slots so that they could be inserted or removed. Cadmium, it will be recalled, absorbs neutrons, hence the number and degree of penetration of the rods determine the rate at which the pile will operate.

Energy Liberated As Heat

In a pile of this kind the energy liberated by virtue of the fission of Uranium 235 manifests itself as heat. This also is true in the much faster reaction which takes place in the atomic bomb. There, the sudden release of energy produces temperatures of the order of millions of degrees. In the self-sustaining pile the temperature, of course, is very much lower, a matter of only a few degrees, if desired. When the University of Chicago pile first went into operation on December 2, 1942, it op-

[1] Described in POWER PLANT ENGINEERING, November 1945, page 100.

[2] See series of articles on the Development of Atomic Energy, POWER PLANT ENGINEERING, September 1945 to March 1946.

erated at the rate of only one-half watt, that is with a heat release of about 1.7 Btu per hour. On December 12 the intensity was run up to 200 watts, that is about 683 Btu per hour.

Later on, a larger experimental pile at the Clinton Engineer Works at Oak Ridge, Tennessee operated at 1800 kilowatts and after new fans were installed this pile was operated at still higher levels. It was on the basis of the experience obtained with the Clinton pile that the great plutonium plant at Pasco, Washington, was finally built. This was known as the Hanford Engineer Works.

The Hanford Plant

Now, of course, the Hanford plant in Washington was built to produce plutonium. No actual figures have been released regarding the rate at which the Hanford plant is running, but it is fairly well established that for the production of a kilogram of plutonium a day, that is 2.2 pounds, a chain reacting pile must release energy at the rate of around one million kilowatts. In other words, at Hanford a million or more kilowatts are being wasted in heating up the water of Columbia River, which is used for cooling the pile. The actual temperature rise, of course, is very small because the quantity of water is so large. It is quite obvious, indeed it was from the beginning, if the temperature at which the plutonium piles operate could be raised enough so that the cooling water could be turned into high or even moderate pressure steam, this steam could then be used to operate conventional steam turbines and thus we would have an atomic power plant. This is the arrangement proposed in most of the atomic power plants now under consideration.

As recently announced, the sum of $2,500,000 has been authorized for the design and construction of the Daniels pile at Oak Ridge, Tennessee, which is to be the world's first high temperature uranium pile. This project is reported to be primarily a means of testing out certain ideas of general pile behavior at high temperatures and is not necessarily intended to be a pilot plant for future power producing units. Engineers at Oak Ridge believe that the Daniels pile will be in operation some time in the spring of this year and that it will produce some power in 1948.

Development of the Daniels Plant at Oak Ridge

The general arrangement of the type of atomic plant envisioned by the control plant offered by the United States to the United Nations Atomic Energy Commission is shown in Fig. 1. It involves a "primary pile" using very pure uranium and possibly thorium and a "secondary" pile using denatured plutonium produced by the primary pile.

Fundamentally, there are no scientific reasons why a plant of this type cannot be built. The only difficulties in the way are those of material and details of design—engineering problems. As far as temperature is concerned the nuclear reaction will go on as effectively at 1500 or 2000 degrees as at 200 deg.

So, it seems quite reasonable to assume that the engineering problems can be solved and that in a comparatively short time we will have a nuclear power plant in operation. It is possible that such a plant will be very much simpler than we now suspect. The plant now under construction at Oak Ridge will be simply a huge concrete box with walls and roof of great thickness. This box or building without windows will be divided into two rooms. In one of them a pile built presumably of graphite, bricks drilled through with numerous holes will function as the furnace. Inside the holes in the graphite are placed rods or cylinders of very pure uranium. When a sufficient number of uranium rods are disposed in the holes, the nuclear reaction starts spontaneously and the uranium begins to heat. The uranium rods do not fit tightly into the holes. There is room for the gas to pass through and be heated by the hot uranium. The heated gas is circulated through a boiler in the adjacent chamber and the steam generated in this boiler is delivered to a turbo-generator unit in another building.

It will be evident to almost anybody that an atomic power plant of this type is relatively simple in its design and principle of operation. The only difficulties at present are the development of suitable materials, the problem of control and questions of safety to personnel. Once these have been solved this type of atomic power plant will operate as effectively and independently and, no doubt as economically, as the modern coal- or oil-fired plant of today. Except for the fact that nuclear energy is used to supply heat to the boiler, this plant is virtually the same as our present day steam plants. That is, it has the same turbine and generator and the boiler also generates steam from some sort of heat input. And it will operate at about the same thermal efficiency, that is, some 80 per cent of the heat in the steam will be wasted in the condenser cooling water.

Since present day coal and oil fired plants operate on this basis, that is, with this great heat loss, it is no criterion by which to condemn the future atomic power plant. Still, those who have been closest to the development of atomic energy wish that some more efficient scheme of utilization could be at-

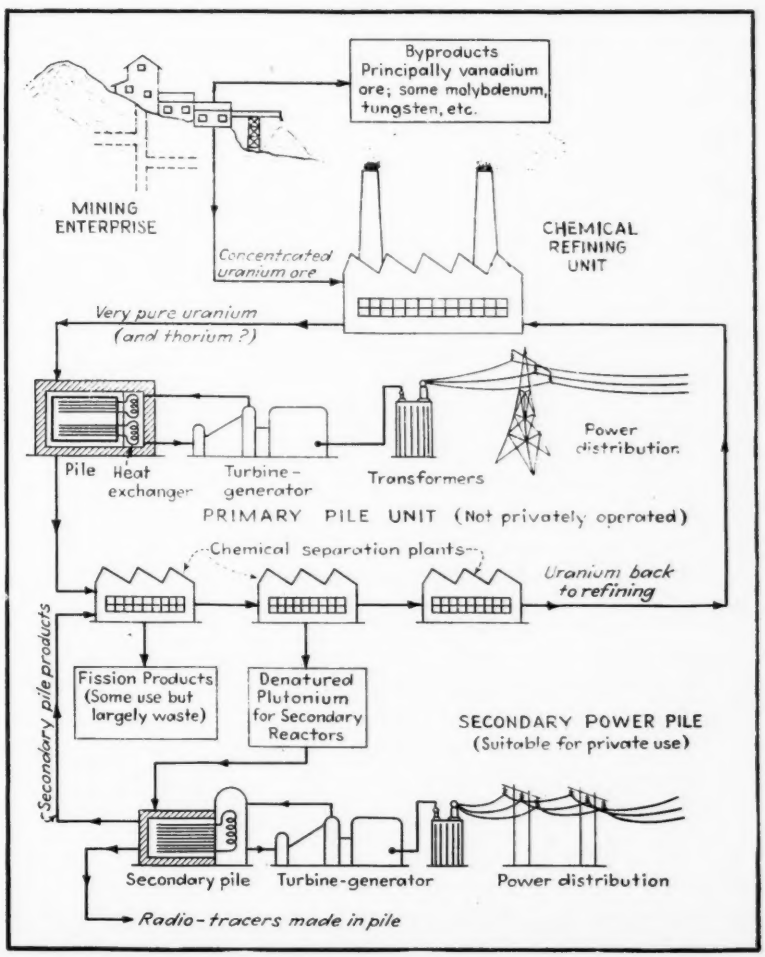


Fig. 1. Idealized atomic energy development envisioned by the control plan offered by United States to the United Nations Atomic Energy Commission

tained. It would be ever so much better and no doubt more efficient if the nuclear energy could be converted directly into electrical energy without the necessity of developing great heat.

Direct Conversion of Nuclear Energy Into Electric Power

The idea of converting chemical energy directly into electrical energy, of course, is almost as old as the science of electricity itself, and it was first realized by Volta when he constructed his first Voltaic pile. This idea saw further development in numerous wet and dry cells. The efficiency of all such electrolytic cells, however, is low and nearly all require materials that are relatively expensive.

This being the case, many investigators, therefore, have devoted much attention to the possibility of generating electricity directly from coal, not with any degree of success however. Years ago Nernst proposed to transfer the energy of coal by treatment in a blast furnace to iron or zinc, and to utilize these metals for the generation of electricity in the form of galvanic elements. Such a process, however, still involves heat and consequent production and radiation losses, and none of the many schemes proposed ever led to practical development.

Fundamentally the generation of electrical energy requires merely the removal of electrons from a normal region where their negative charges are neutralized by an equal number of positive charges to a region where the opposite charges are not so satisfied. Thus when we rub a stick of sealing wax with flannel (both insulators) we rub some of the electrons off the atoms composing the flannel and leave them on the surface of the atoms composing the wax. This wax, therefore, becomes negatively charged and the flannel positively charged. Since the surface atoms or molecules of the flannel are deficient in electrons and the surface of the wax have an excess, if the wax and flannel are left together after being rubbed there will be a readjustment of electrons, the excess of the wax returning to the deficient atoms of the flannel. This readjustment of electrons no matter how effected, through a wire or otherwise, constitutes an electric current.

In the case of the wax and the flannel the number of electrons involved and the amount of energy is very small, but it will be obvious that if this same process could be accomplished on a large scale, a great amount of power might be produced. When we rub the surface of the wax with the flannel we merely rub off some of the superficial electrons on a very small number of atoms close to the surface. For the most part, the atoms of the wax are left unchanged.

If We Could Isolate Electrons

An atom consists of a positively charged nucleus surrounded by a number of orbital electrons. If we could, by rubbing or otherwise, remove all the electrons from an atom, the potential energy (in terms of potential difference) stored up by virtue of such separation would be relatively great. If this could be done to a large number of atoms, enormous potentials would be built up. If, for example, we could collect and isolate two grams of electrons and if these electrons could be divided into two equal parts and held one centimeter apart, as in Fig. 2 the two groups of electrons would repel each other with a force of 320 million, million, million, million tons. This enormous pressure is millions of times greater than the weight of all the oceans of the earth. Of course, it would not be possible to keep even a kilogram or a gram or even a ten-thousand part of a gram of electrons together, because each electron would repel every other electron and the mass would tend to fly apart with explosive violence the instant they were brought together.

There are various ways of removing a few electrons from atoms. It can be done as already explained by rubbing, this is known generally as frictional electricity. In a primary battery it is

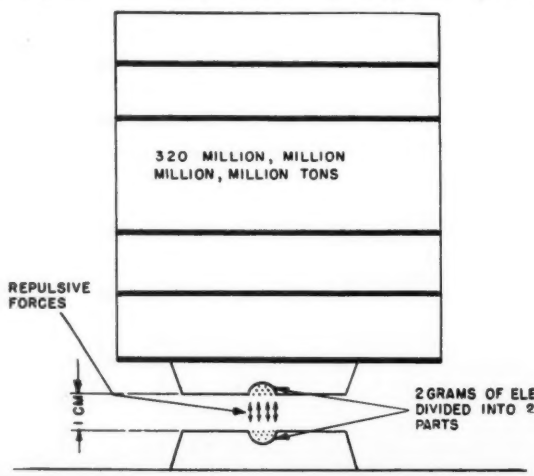


Fig. 2. If it were possible to collect two groups of electrons and divide them into two equal parts, one centimeter apart, the two groups would repel each other with a force of 320,000,000,000,000,000,000,000,000 tons!

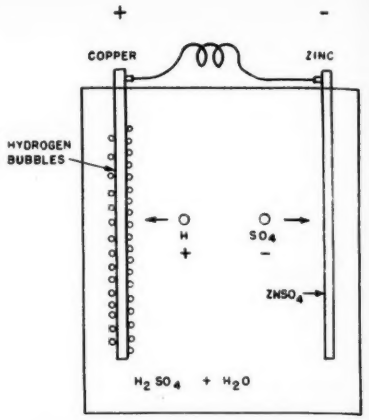


Fig. 3. In a simple primary cell the sulphuric acid H_2SO_4 is broken up into positive hydrogen, H, ions and negative SO_4 ions. The hydrogen is liberated in the form of gas bubbles at the positive copper terminal and the negative SO_4 ion combines with a positive zinc ion to form $ZnSO_4$—zinc sulphate

accomplished by the breaking up of molecules into ions. In the case of sulfuric acid (H_2SO_4) each molecule of acid breaks up into positive ions H and negative ions SO_4. In other words the SO_4 molecules take the electrons away from the hydrogen atoms leaving only the nuclei, that is the proton. In living organisms, similar but probably very much more complex processes occur. According to one hypothesis the release of a chemical called acetylcholine present in nervous tissue and its break down by an enzyme, generates electric current which carries the impulse on to the next portion of the nerve. In the electric eel several thousand such generating elements are arranged in series from head to tail and can produce up to 800 volts.

In the electric generator the separation of electrons is accomplished by a magnetic field. Here the magnetic field acts somewhat the same as an impeller in a centrifugal pump. The magnetic field forces the free electrons in the conductors toward one end of the system. This accumulation of electrons on one side of the system together with a corresponding absence of electrons on the other side manifests itself as a difference of potential.

Principle of Metallic Conduction

The number of electrons involved in such currents, as are produced by even our largest electric generators, though extremely large in terms of numbers is small in proportion to the total number of electrons in the atoms of which the conductors are made. In metallic conductors there is always present a certain number of so-called free electrons—electrons not inherently associated with atoms or so loosely bound to atoms that even a slight force tends to remove them.

Consider a bar of metal. The atoms in it will be spaced close together, so close that they are limited in their movements and are prevented from making any extended excursions from

their normal position. Under these conditions it is apparent that the external electrons in the outer orbits of adjacent atoms will at times come close together. Occasionally an electron belonging to one atom will actually come within the sphere of influence of the nucleus of an adjacent atom, thus tending to satisfy simultaneously the demands of two atoms. When this occurs one of the atoms will release its hold on one of its outer electrons permitting it to wander off to a nearby system which, due to having lost an electron in this manner, needs it. Since the process is duplicated simultaneously in billions of atoms throughout the bar at any particular instant, there will be billions of these wandering or free electrons in existence at any particular moment. Yet compared to the total number of electrons in all the atoms their number is still exceedingly small.

When the two ends of such a bar of metal are connected to a source of electric potential so as to establish an electric field through the bar or if the bar is subjected to a changing magnetic field, the free electrons move along the length of the conductor, although their progress will be impeded by countless billions of atoms in their path. There will be innumerable boundings back and forth and a single electron will undergo innumerable "captures" and "releases," but if the sum total of all the free electrons is considered, there will be superimposed upon the haphazard motions of the electrons a directed motion along the length of the bar. In other words, there will be a slow drift of electrons along the bar. This drift constitutes the electric current.

In solid conductors the free electrons are always very closely associated with the atoms of which the conductors are composed. Only in the vacuum tube do we have a condition where the electrons are observed entirely apart from matter. When the cathode of a thermionic tube is heated, electrons liberated from its surface by a process similar to evaporation in the case of liquids, are drawn across the space between the cathode and anode by the positive potential impressed on the anode. Despite the great repulsive forces between the individual electrons due to the fact that they are charged to the same sign, there is little tendency for the electrons to diverge, first because the transit time is so short and secondly because of the relatively great distance between the electrons. In certain types of "beam" power tubes, the electrons are forced into a narrow beam by positive deflecting electrodes, but even in such beams the electron density is extremely rare. In other words, the number of electrons released from the surface of a hot cathode in a thermionic tube is small compared to the number of electrons in the atoms of the cathode itself.

Possible Liberation of Electrons in Nuclear Fission

Thus we see in all cases it is possible to remove only very few of the electrons belonging to any atomic system by the means ordinarily at our disposal. It is this fact that leads nuclear physicists to consider the possibility of isolating electrons by atomic fission. When an atom of U-235 splits as a result of slow neutron capture, it is quite probable that the external electrons are subject to violent disturbances and that many them are literally blown out of the range of the influence of the nucleus. This, of course, lasts for only a very brief moment. Recombination of these electrons and the nuclei of the fission products occurs immedately afterwards, giving rise to the intense flash of light in the case of the atomic bomb. This flash of light is due to the energy emitted by the recombination of electrons with their atomic systems. However, if before such recombination occurs by some means we could direct these momentarily free electrons against a collector of some sort, the collector would become the source of powerful electric currents. This idea is illustrated in Fig. 4.

Whether such a process can ever be made possible is something only future years can disclose. But it is interesting to speculate about the matter. It might not be necessary to collect only the electrons of the disrupted uranium atoms. It might be possible to direct the energy of fission so that the electrons of ordinary more stable atoms would be stripped from their nuclei and directed to a collecting system. In such a process, heat would still be produced as a result of nuclear fission, but since much of the kinetic energy of the fission particles would be used to strip other atoms of their electrons the process would be much more efficient than the processes now proposed to produce energy from nuclear fission.

The thermionic tube suggests another possibility. It is well known that the electron emission from a hot cathode is a function of the temperature of the cathode. The higher the cathode surface temperature the higher the electron emission. Since thermonuclear reactions are capable of producing temperatures very much higher than chemical or ordinary electrical resistance methods, perhaps materials could be heated to such extremely high temperatures that virtually all the electrons from the atoms of a gas would be liberated and directed towards an anode in the form of an arc. Perhaps energy could be withdrawn from such a system.

All this, of course, is in the realm of pure speculation but unless we do speculate about these matters there will be little hope for future progress. Without doubt all of these ideas and many others are being considered by nuclear physicists all over the world, and even though we may never achieve the direct conversion of nuclear energy into electric power we will learn many things merely by trying to achieve such a conversion. In the meantime, we can build atomic power plants along conventional lines using steam boilers and turbines and perhaps also gas turbines.

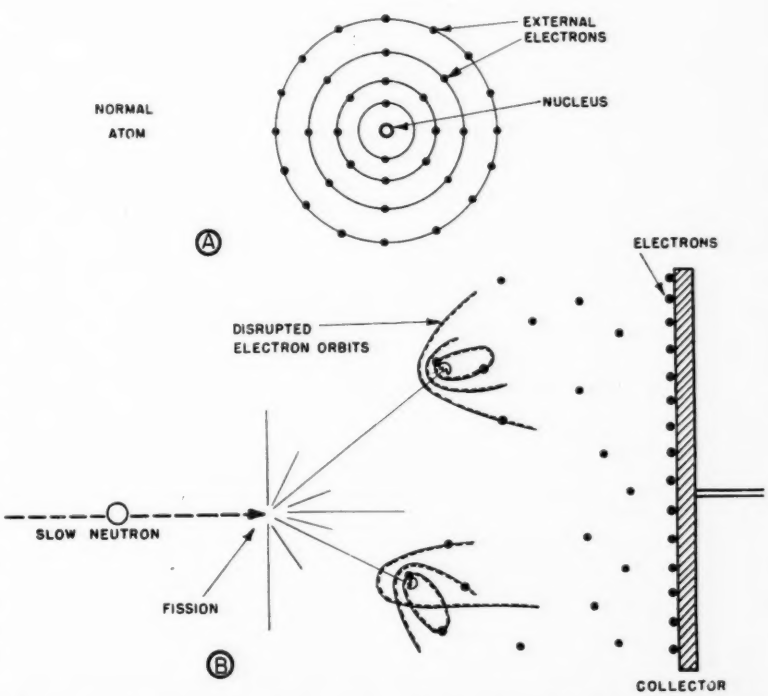


Fig. 4. Above at A is shown a diagram of a normal atom. It consists of a positively charged nucleus surrounded by a system of electrons disposed in a series of concentric orbits. Below at B a slow neutron has produced fission in this atom and the electron orbits are so disrupted that the electrons are thrown against a collector plate which therefore acquires an electric charge

Capacitors For Power Factor Correction

By R. E. MARBURY Manager, Capacitor Engineering, Switchboard & Control Division,

Westinghouse Electric Corp., East Pittsburgh, Pa.

This article contains a lot of sound, fundamental information on capacitors which the average engineer would have to search for a long time or he would have to figure it out for himself at much effort. For example, how can a bank of three phase capacitors be reconverted for service at higher voltage? This article answers such questions. It gives the average engineer all he needs to know about the characteristics, testing and maintenance of capacitors

THE USE OF CAPACITORS in industrial plants for correcting low power factor conditions has become quite common. There are details in connection with characteristics, types, methods of testing and construction that are, therefore, of general interest to those who have to use and maintain capacitors. The purpose here is to discuss capacitors and some of the fundamentals pertaining to their operation.

A capacitor is a device consisting of a large area of insulation separating two systems of metal surfaces. This insulation is commonly referred to as the dielectric, and is the actual working element of the capacitor. There is no metallic connection between these two metal surfaces. However, when these two surfaces are connected to a source of potential, energy is stored in the dielectric. If the source of potential is d-c, a definite quantity of energy is stored, depending on the area of the dielectric, its characteristic and the voltage applied.

When d-c is applied to a capacitor, the current is high at the instant the connection is made and falls rapidly until a value which represents the leakage current is reached. The leakage current is determined by the insulation resistance. Inerteen capacitors have a leakage corresponding to a minimum product of 2000 when the resistance in megohms is multiplied by the capacitance in microfarads. A 1 mf capacitor would be at least 2000 megohms, or a ½ mf capacitor would be 4000 megohms.

If the voltage is reversed the energy will be removed and restored again with the opposite polarity, after which, the current again drops to nearly zero. If the source is alternating, energy will be stored and removed during each half cycle, and the current, due to this constant charging and discharging, will give rise to a continuous flow, as indicated by an ammeter. The current measured on a sine wave voltage will depend upon the electrical size of the capacitor in microfarads, the voltage and the frequency in cycles.

I (amperes) $= E \times 2\pi f C \times 10^{-6}$ or if E = Kilovolts, C = microfarads and frequency is 60 cycles, this may be simplified as follows:

I (amperes) $= E \times 0.377 \times C$

Insulation is important in all electrical equipment. Nevertheless, it usually plays the secondary role of keeping conductors separated. In most apparatus it can conveniently be used generously, and two thousandths to twenty thousandths of an inch of insulation is used for each 100 volts applied.

Since insulation in capacitors is the principal working element, it must be used efficiently, and the art of building capacitors resolves itself into the art of developing special types of insulation having remarkable quality and uniformity of characteristics which permit the use of very thin layers of insulation. Even for a fixed thickness of insulation the energy stored, and, therefore, the rating of the capacitor, can be substantially increased by increasing the actual capacity of the insulation for storing energy, or increasing the dielectric constant. Most insulation, such as oil impregnated paper, has a dielectric constant of three. Inerteen impregnated

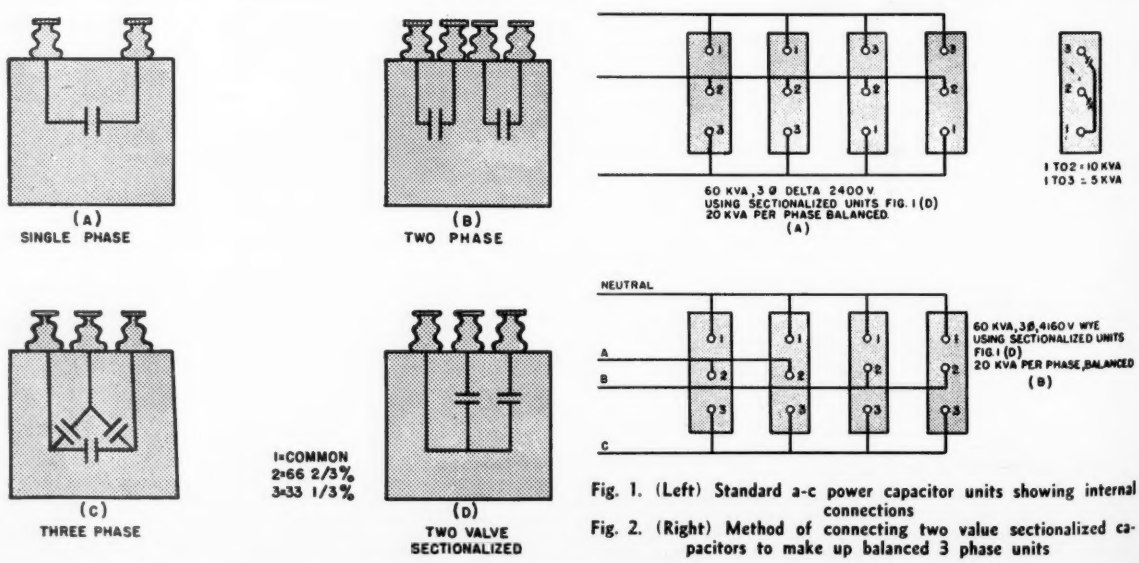
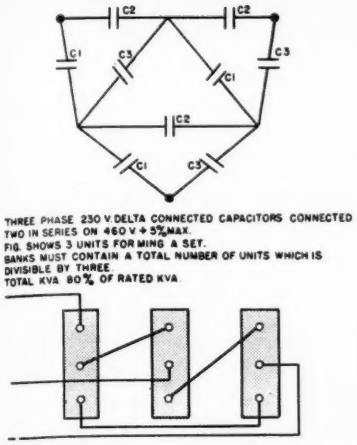


Fig. 1. (Left) Standard a-c power capacitor units showing internal connections

Fig. 2. (Right) Method of connecting two value sectionalized capacitors to make up balanced 3 phase units



THREE PHASE 230 V DELTA CONNECTED CAPACITORS CONNECTED TWO IN SERIES ON 460 V ± 5% MAX.
FIG. SHOWS 3 UNITS FOR MING A SET.
BANKS MUST CONTAIN A TOTAL NUMBER OF UNITS WHICH IS DIVISIBLE BY THREE.
TOTAL KVA 80% OF RATED KVA

Fig. 3. Method of connecting three 230 v, 3 phase units to give a 3 phase 460 v unit

paper has a constant of five. This added energy is due to a special property of di-polar materials. Inerteen is the most satisfactory di-polar impregnant yet discovered for 60 cycle power capacitors.

Most a-c capacitors have a discharge resistor assembled inside of the case, which is for the purpose of automatically discharging them after they are disconnected from the circuit. Since this value of resistance is low compared to the resistance of the insulation itself, the current which such a capacitor will draw on a d-c circuit will be determined largely by the value of this discharge resistance. A measure of resistance, therefore, does not give any information on the condition of the insulation in a capacitor containing internal discharge resistances.

The electrical size of a capacitor is technically measured in microfarads. A more convenient term for a-c capacitors is volt-amperes. This is simply the product of the current drawn, and the voltage, when a given voltage is applied. A still more common term is kva. A 15 kva capacitor is a capacitor which will draw 15 kva when operated at rated voltage and frequency. A 15 kva, 460 v capacitor is simply one which will draw a current of 32.6 amp when connected to 460 v. The microfarad value a 15 kva capacitor must have in order to draw 32.6 amp on 460 v depends on the frequency.

If a 15 kva capacitor on 460 v draws 32.6 amp, it must have a reactance of 14 ohms.

The capacitance this unit must have in order to have a reactance of 14 ohms depends on the frequency. If the frequency is 60 cycles, then the capacitance corresponding to a reactance Xc of 14 ohms is:—

$$\text{Capacitance in Mfds} = \frac{1 \times 10^6}{2\pi f X_c} = 190$$

If the frequency were 120 cycles, the capacitance needed would have been 95 microfarads.

Since the kva rating of a capacitor is governed partly by its radiating surface, units of a given kva rating are about the same size even though rated at widely different voltages, so long as they are designed with substantially the same insulation voltage stress. A 2400 v 15 kva unit and a 460 v 15 kva unit are different in size, largely due to bushings.

If the amount of insulation is reduced less than the voltage, as, for example, in the case of a 230 v unit which has 70 per cent of the insulation thickness of a 460 v unit instead of 50 per cent, the unit will be larger in proportion to kva than the 460 v unit. A 15 kva, 460 v capacitor is about the same size as a 7½ kva, 230 v unit, due to the fact that mechanical limitations prevent using thinner insulation in 230 v capacitors. Capacitors for 230 v are, therefore, not subject to the same ambient temperature limitations as capacitors rated at 460 v and higher, because of the liberal case size in terms of kva rating.

A capacitor unit is a very efficient piece of apparatus, in that a very small part of the energy handled is converted into heat. A capacitor of the Inerteen type has a nominal loss of ⅓ of 1 per cent. Therefore, a 15 kva unit has a loss of $0.0033 \times 15{,}000 = 49.5$ watts.

The following formulae will be useful in connection with testing problems that may arise.

$$I = E\,2\pi f C \times 10^{-6}$$

$$\text{kva} = \frac{E^2\,2\pi f C \times 10^{-6}}{1000}$$

$$X_c = \frac{1 \times 10^{-6}}{2\pi fC}$$

I = Current in amperes

E = rms voltage
C = Microfarads
X_c = Capacitor ohms
f = frequency in cycles

Knowing the kva rating and the voltage, one can easily compute the X_c ohms, and from this derive the capacitance in microfarads and calculate the current the capacitor should draw on a given voltage and frequency.

Capacitor units for a-c service are made in single phase, two phase, three phase and two-value single phase.

Single phase units have two terminals with one value of capacitance. One terminal may be common to the case.

Two phase units actually consist of two separate values with four terminals, and could be considered as two separate and equal capacitors, each having two terminal bushings.

Three phase units are divided internally into three equal values, and connected in delta, with (3) terminal bushings.

Two value capacitors are capacitors having one value equal to 33⅓ per cent and one 66⅔ per cent with one common terminal, and with two other terminals. These are usually referred to as sectionalized capacitors.

These are shown in Fig. 1, (a), (b), (c), (d).

A single phase unit, Fig. 1 (a), if for 460 v, 15 kva, would be made up of one 190 microfarad element assembly, and would draw a current of 32.6 amp. These units are usually used in large assemblies, and groups of units are delta connected on three phase circuits.

A 460 v, 2 phase unit, Fig. 1 (b),

Fig. 4. Cut-away view showing internal construction of a standard a-c power capacitor

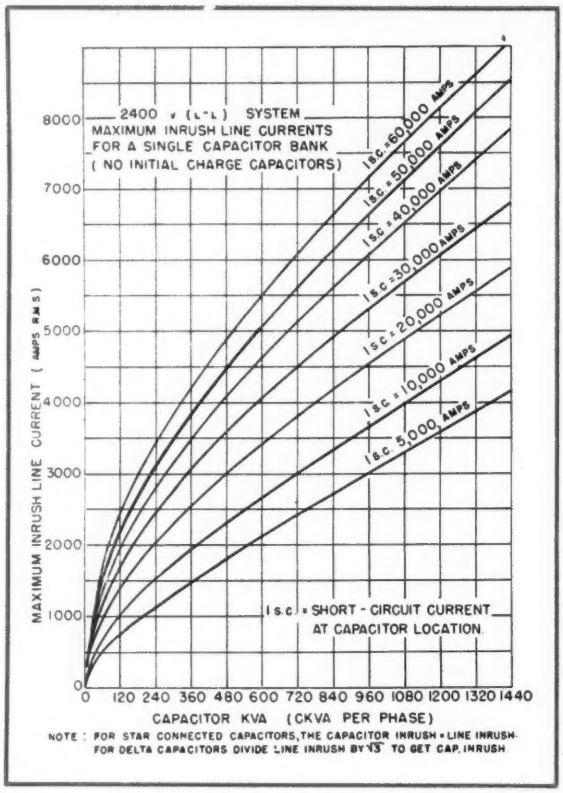


Fig. 5. Maximum capacitor inrush current on a 2400 v line to line system

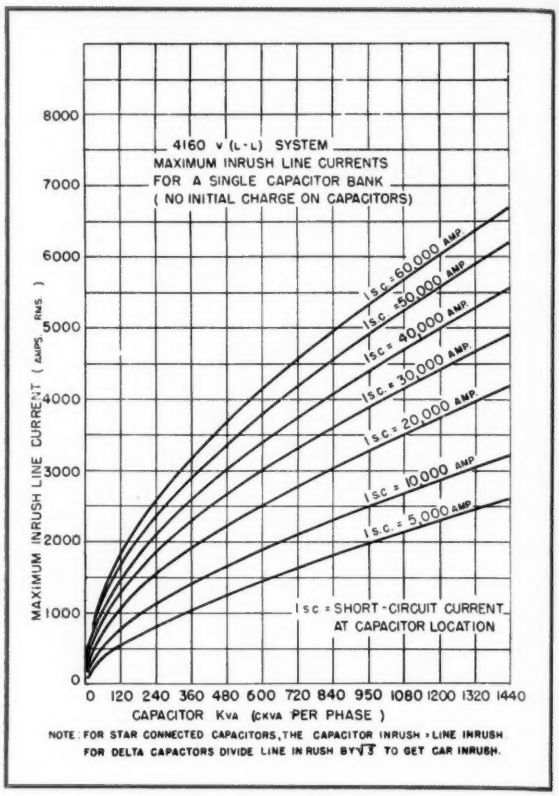


Fig. 6. Maximum capacitor inrush current on a 4160 v line to line system

would consist of two 95 microfarad elements and draw 16.3 amp per phase.

A 460 v, 3 phase unit, Fig. 1 (c), would consist of three, 63.3 microfarad elements, and draw a phase current of 18.85 amp.

A 2400 v, 2 value or sectionalized unit would have one 2.3 microfarad element, and on one 4.6 microfarad element. Units of this type are used to permit operation on 2400 v, delta or 4160, wye, when the total number of units are divisible by 2. If divisible by 3, single phase, 2400 v units could obviously be connected delta on 2400 and wye on 4160, but this would give steps of 45, 90, 135 kva. If steps of 30, 60, 90 and 120 kva are desired, involving 2, 4, 6, or 8 units, one solution is to use 3 phase units, Fig. 1 (c). These, however, cannot be reconnected for 4160 v and are objectionable, because it is frequent practice to change 2400 v lines to 4160 v. The unit such as shown in Fig. 1 (d) is the solution.

Fig. 2. (a) and (b) shows how these units would be connected to make up a 60 kva bank of capacitors.

Single phase units are sometimes used in series if insulated on extra insulators, or if the total voltage is within the voltage class of the bushings. Thus, two 230 v units could be connected in series, but two 460 v units could not, without supporting each unit on insulators.

Obviously, two phase units can be used as single phase units if the two halves are connected in parallel. The two halves of a 230 v unit could be connected in series, making a 460 v, 7½ kva unit. The two halves of a 2400 v, 2 phase unit cannot be connected in series because this exceeds the voltage class of the bushings.

Three phase, 230 v units can be operated in series on 460 v if they are made up in groups of 3 units, as shown in Fig. 3. The total is 80 per cent of the rated kva or 18 kva for 3 7½ kva, 230 v units, line voltage should not exceed 460 v by more than 5 per cent.

Three phase units may be used on single phase by shorting one phase, and thus, obtaining 66⅔ per cent of the total kva. If connection is merely made to any two of the three terminals, the kva will only be 50 per cent.

The working element of a 60 cycle Inerteen capacitor consists of a group of wound sections connected in series or parallel, or series-parallel, depending on the rating. Each section consists of two strips of aluminum foil coiled up with a very thin and special type of paper between them.

The assembly of these sections in an insulating structure, after being dried and treated with Inerteen, becomes the working element.

The case is of welded sheet steel construction, with mounting brackets if intended for outdoor use, and mounting studs if intended for indoor use.

The bushings are of the soldered-to-porcelain type with large ½ in. threaded studs for making connections.

The outdoor units are given a special metallic zinc coating to give long resistance to the weather. The indoor units are painted in a conventional manner to resist the normal conditions to which indoor units may be exposed.

Standard, 3 phase units are delta connected, while special 3 phase capacitors used in connection with lightning arresters for protection of rotating machines are star connected with the neutral connected to the case.

It is essential that consideration be given to the arrangement of capacitor units and complete equipment as an installation to provide adequate ventilation and dissipation of losses. Capacitors are designed to operate at a lower temperature rise than for most other types of apparatus, for these specific reasons:

(1) Capacitors operate at full load continuously, eliminating the benefit of an average temperature rise derived from the usual load cycle under which most other apparatus operates.

(2) Capacitors are designed to operate at comparatively high dielectric stresses or reasons of economy. The combination of these stresses, with operation at excessive temperature for extensive periods of time, will result in gradual deterioration and shortened life.

Capacitor ratings are based on maximum ambients with allowance for heat dissipation by radiation and convection. The arrangement and mounting of units and conditions of installation will affect

the heat dissipation, and, thereby, limit the ambient temperature at which the equipment may be operated. The following points are important in relating the operating temperature of a capacitor to the conditions of installation.

(1) An individual capacitor unit, non-enclosed, will dissipate losses with the least temperature rise (the heat dissipation being approximately 45 per cent by radiation and 55 per cent by convection).

(2) Units openly mounted on a pole are benefited by air currents and freely ventilated, and are therefore, rated for 50 C ambient. The effect of sun load is off-set by the night conditions, and the fact that about 12 hours are required for capacitors to reach steady state conditions of temperature.

(3) Mounting of capacitor units in rows side by side and/or in tiers increases the temperature rise in each tier above the one below because of heating of the air stream and because of reduced radiation.

(4) Enclosure of capacitor units in a housing or room increases the temperature rise because of reduced radiation and restriction of natural circulation of air.

(5) Capacitor units subject to radiation from surrounding surfaces whose temperature is above ambient will show a higher rise, as for example, a concrete floor over a furnace room.

In view of these considerations, various types of capacitors or assemblies are designed to operate at, or below, certain specified ambient temperatures. Special capacitors can be designed for higher ambients, or standard conditions may be obtained, or more ventilation provided.

Capacitors cause a voltage rise at the point where they are located; thus, the operating voltage is increased. Capacitors are, therefore, more likely to operate at over-voltage than other types of equipment that cause a voltage drop at the point where they are located. Recognizing this factor, the nameplate voltage rating of capacitors and permissible over-voltage operation are higher than those established for most other circuit devices, such as motors. For example, a motor rated 400 v is recommended for operation on the same circuit where the capacitor rating is 460 v.

Standards have been established which allow a maximum permissible operating voltage of 110 per cent. Capacitors should not be applied on circuits whose average voltage over any 24 hour period exceeds the nameplate rating by more than 5 per cent. The difference between 105 per cent and 110 per cent provides the necessary margin for voltages above the average or for excess kva burden due to harmonics.

Standard capacitors are also designed to operate at 135 per cent kva. 110 per cent voltage means 121 per cent kva, while 105 per cent voltage means 110 kva. At 105 per cent voltage, 25 per cent kva is still available for harmonic kva burden.

High overvoltage transients are uncommon in most power circuits, but may be encountered with certain series resonant conditions. Switching or other devices which allow restriking of the arc during current interruptions should not be used. Sufficient time should be allowed for the capacitor to discharge between successive switching operation.

Capacitors connected to exposed lines should be protected by station-type or line-type lightning arresters located as near as possible to the capacitors. If capacitors are indoors, the arresters may be located at the line entrance to the building. Installation should be made according to **NEMA** Lightning Arrester Standards. Capacitors connected between line and grounded neutral will be effective in reducing the slope of a travelling wave front, but since the available energy will sometimes be sufficient to charge the capacitors to an abnormally high voltage, arresters in parallel with the capacitors are recommended for protection.

As pointed out previously, the current drawn by a capacitor is equal to:

$$I = E^2 \pi fC \times 10^{-6}$$

If the voltage wave is non-sinusoidal, it may be considered as made up of two or more frequencies, H_1, H_2, H_3, etc., and the measured voltage will be the square root of the sum of the squares of these voltages.

RMS Volts =

$$(V_{H_1})^2 + (V_{H_2})^2 + (V_{H_3})^2 \text{ etc.}$$

The capacitor will draw a certain kva

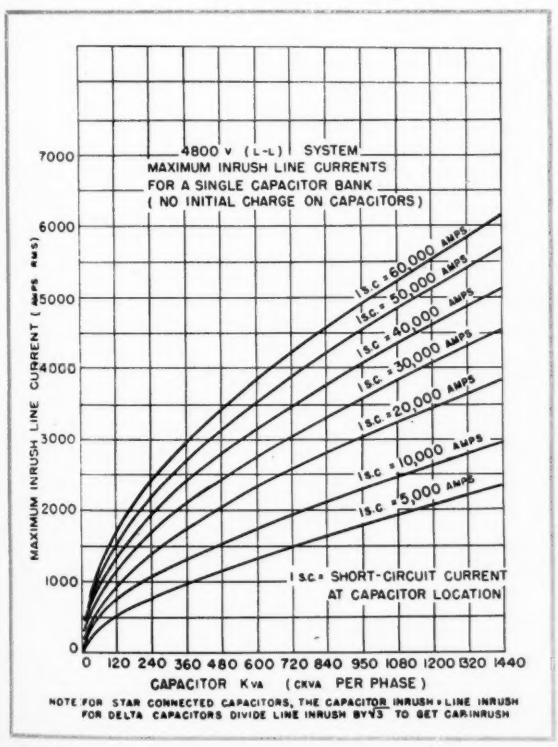

4800 v (L-L) SYSTEM
MAXIMUM INRUSH LINE CURRENTS
FOR A SINGLE CAPACITOR BANK
(NO INITIAL CHARGE ON CAPACITORS)
MAXIMUM INRUSH LINE CURRENT (AMPS R M S)
7000
6000
5000
4000
3000
2000
1000
0
I s.c. = 60,000 AMPS.
I s.c. = 50,000 AMPS.
I s.c. = 40,000 AMPS.
I s.c. = 30,000 AMPS.
I s.c. = 20,000 AMPS.
I s.c. = 10,000 AMPS.
I s.c. = 5,000 AMPS.
I s.c. = SHORT-CIRCUIT CURRENT AT CAPACITOR LOCATION
0 120 240 360 480 600 720 840 950 1080 1200 1320 1440
CAPACITOR Kva (CKVA PER PHASE)
NOTE FOR STAR CONNECTED CAPACITORS, THE CAPACITOR INRUSH = LINE INRUSH
FOR DELTA CAPACITORS DIVIDE LINE INRUSH BY √3 TO GET CAP INRUSH

Fig. 7. Maximum capacitor inrush current on a 4800 v line to line system

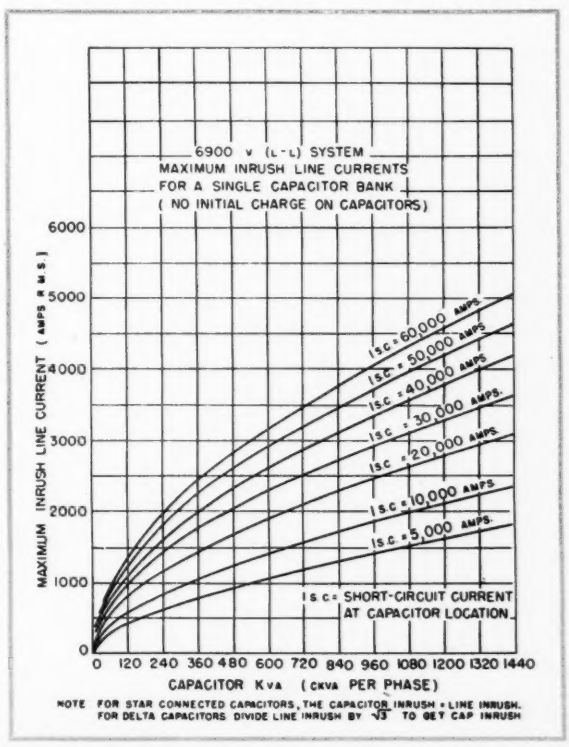

6900 v (L-L) SYSTEM
MAXIMUM INRUSH LINE CURRENTS
FOR A SINGLE CAPACITOR BANK
(NO INITIAL CHARGE ON CAPACITORS)
MAXIMUM INRUSH LINE CURRENT (AMPS R M S)
6000
5000
4000
3000
2000
1000
0
I s.c. = 60,000 AMPS.
I s.c. = 50,000 AMPS.
I s.c. = 40,000 AMPS.
I s.c. = 30,000 AMPS.
I s.c. = 20,000 AMPS.
I s.c. = 10,000 AMPS.
I s.c. = 5,000 AMPS.
I s.c. = SHORT-CIRCUIT CURRENT AT CAPACITOR LOCATION
0 120 240 360 480 600 720 840 960 1080 1200 1320 1440
CAPACITOR Kva (CKVA PER PHASE)
NOTE FOR STAR CONNECTED CAPACITORS, THE CAPACITOR INRUSH = LINE INRUSH.
FOR DELTA CAPACITORS DIVIDE LINE INRUSH BY √3 TO GET CAP INRUSH

Fig. 8. Maximum capacitor inrush current on a 6900 v line to line system

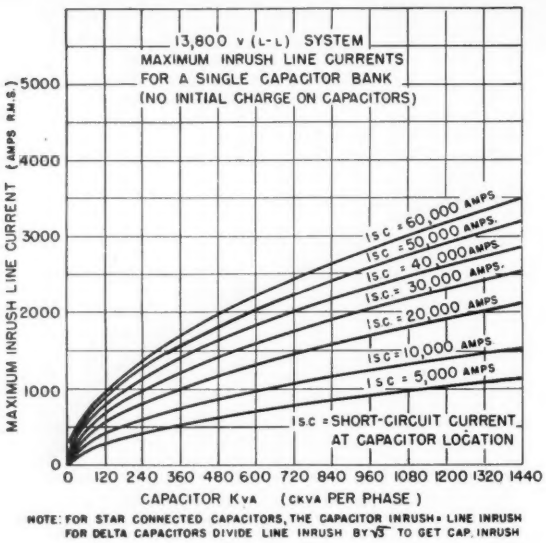

13,800 v (L-L) SYSTEM
MAXIMUM INRUSH LINE CURRENTS
FOR A SINGLE CAPACITOR BANK
(NO INITIAL CHARGE ON CAPACITORS)
MAXIMUM INRUSH LINE CURRENT (AMPS R.M.S.)
5000
4000
3000
2000
1000
0
Isc = 60,000 AMPS.
Isc = 50,000 AMPS.
Isc = 40,000 AMPS.
Isc = 30,000 AMPS.
Isc = 20,000 AMPS
Isc = 10,000 AMPS
Isc = 5,000 AMPS
Isc = SHORT-CIRCUIT CURRENT AT CAPACITOR LOCATION
0 120 240 360 480 600 720 840 960 1080 1200 1320 1440
CAPACITOR Kva (CKva PER PHASE)
NOTE: FOR STAR CONNECTED CAPACITORS, THE CAPACITOR INRUSH = LINE INRUSH
FOR DELTA CAPACITORS DIVIDE LINE INRUSH BY √3 TO GET CAP. INRUSH

Fig. 9. Maximum capacitor inrush current on a 13,800 v line to line system

at the line fundamental frequency H_1, and a certain kva at voltage V_{H_2}, V_{H_3}, etc. The total operating kva will be the sum of these values.

Abnormal capacitor currents, due to excess fundamental voltage or harmonic voltage added to the fundamental, may occasionally be encountered. Blowing of fuses and/or over temperature operations may be the first noticeable indication of such an overload condition. Capacitors and auxiliary devices are designed to carry 135 per cent rated kva maximum including kva due to fundamental voltage and to harmonic voltages. If the total kva exceeds this value, one harmonic will usually predominate.

If the harmonic currents are sufficient to result in operation of the capacitor in excess of 135 per cent kva, one or more of the following remedies should be considered.

(1 Relocation of part or all of the capacitors to other parts of the circuit may reduce over-current due to partial resonance, by changing the circuit constants.

(2) Capacitors may be switched off the circuit during periods in which overcurrents are likely to occur, Automatic control actuated by change in current, change in voltage, change in reactive kva or by time clock may be used.

(3) If these solutions are not applicable, it will be necessary to add inductance in the circuit to make the capacitor resonant to a frequency higher than the predominating harmonic, or to insert a filter ahead of the capacitor to introduce impedance at the particular troublesome frequency.

In either case, it is necessary to determine the harmonic frequency, or frequencies present and the current flowing through the capacitor at these frequencies. These data may be obtained best by means of a harmonic analyzer or volt meter and ammeter with filters, and arranged to read voltage and current at various frequencies.

When series reactors are used, it must be noted that they produce a boost in the voltage on the capacitor by an amount equal to the capacitor current times the reactance ohms. Unless special rated capacitors are used, the use of reactors is limited to relatively small amounts, such as a few percent if one is to leave an adequate margin between the capacitor average operating voltage and the maximum permissible operating voltage.

Filters are sometimes used because the needed high impedance to the harmonic can thus be obtained with a minimum boost in the 60 cycle voltage on the capacitor.

The inrush current, drawn by a capacitor, is larger than encountered with other apparatus because of the impedance frequency characteristics of capacitors. We are interested in this inrush for the following reasons.

(1) Momentary ratings of breakers should be well above the possible inrush current.

(2) Contact or switch maintenance is affected, especially in repetitive switching.

(3) Fuses must be liberal and never less than 1.65 per cent of the normal current.

The inrush current must be considered on two bases, one where a single capacitor is switched on the line, and other where banks are switched in parallel with banks already energized.

The line inrush current depends upon the size of the capacitor, the line voltage, and the short circuit current the line is capable of producing without the capacitor.

Figures 5, 6, 7, 8 and 9 show the line inrush currents to be expected on 2400, 4160, 4800, 6900 and 13800 v systems, line-to-line voltage, and based on allowing the capacitor to completely discharge before switching on.

In the case of parallel banks, the inrush is governed by the resistance between banks, and can be easily reduced to or below the value of line inrush for the same size bank by introducing a very small amount of inductance between banks. Figure 10 gives two cases on the basis of 2300 v source, and will serve to illustrate the relative magnitudes of current.

Inspection should be made within eight to twenty-four hours after installation of a capacitor unit or equipment, and at the first periods of light load on the circuit when maximum overvoltage will be obtained. *It is recommended practice to always allow time to discharge and then short capacitor terminals together, and to ground before touching any live parts.*

Readings of voltage and current in each phase should be made to determine that:

(1) Phase voltages are balanced within the limits of the capacitor rating.

(2) Check operating current in comparison to kva rating to determine presence of harmonic currents in excess of allowed values.

Allowance should be made for the fact that manufacturing tolerances are minus zero plus 15 per cent on individual capacitors. This should give a most probable excess of 7½ per cent on large banks and on excess up to 15 per cent on single units.

Regular inspection of capacitor installation on an established schedule should include a check of ventilation, fuses, temperature and voltage conditions. Capacitor bushings and insulating surfaces should be cleaned periodically, depending on the rate of accumulation of conducting material on the insulators. Capacitor units or equipments exposed to weathering should be repainted periodically to prevent excessive corrosion, consistent with prevailing conditions and practices, unless units are metallized with zinc.

Capacitors to be installed under conditions covered by the National Electrical Code are provided with means of reducing the residual voltage in accordance with code requirements. This is usually accomplished by means of discharge resistors built into the capacitor units. Additional discharge means is sometimes used for providing more rapid discharge, as for example in the case of automatically switched banks.

In some capacitor applications, as for example series capacitors used with resistance welders, the discharge means is external to the capacitors and connected automatically when the line switch is opened. It is necessary for series capacitors to hold their charge between welding operations to avoid variable weld characteristics, so they are only discharged when the welder is disconnected from the line.

Capacitors not subject to the requirements of the National Electrical Code are provided with means of reducing the residual voltage to approximately 50 v within five minutes after the capacitor is disconnected from the source of supply.

Capacitors which are automatically controlled shall have discharge means which reduce the residual voltage to 50

v or less, between one switching operation and the next.

The use of a discharge device is in all cases intended to supplement, rather than displace, the practice of short circuiting a unit before handling.

It is sometimes desirable to make tests on capicitator units to determine if the units are in good operating condition. It is not practical to make the same tests as were made in the factory, but the following tests should pick out any units that have failed, or which are not in satisfactory condition to return to service.

(1) *Test for insulation between terminals and case.*

Support capacitor on insulating blocks, or porcelains.

Use a voltage equal to twice the rated voltage of the capacitor. It is preferable to insert sufficient resistance or reactance in the circuit to limit the current in case the unit is grounded.

Use a 10 amp fuse.

Apply voltage from the case to the terminals for one minute connecting all terminals together for this test.

This test applies only to capacitors where the case is not a terminal. It also is not applicable to internally star connected three phase units where the neutral is connected to the capacitor case. In these cases, the capacitor must be tested as shown for terminal to terminal tests.

(2) *Terminal to terminal voltage test and check of capacitance.*

Set up circuit same as for terminal to case test, using not more than 175 per cent of the rated voltage of the capacitor for 1 minute, and using a fuse of the current rating recommended for the capacitor, or one whose rating is 2 times the expected normal current.

Measure the applied voltage.

Measure the current. A shorting switch should be placed around the ammeter and opened only after it is evident that the capacitor is not shorted.

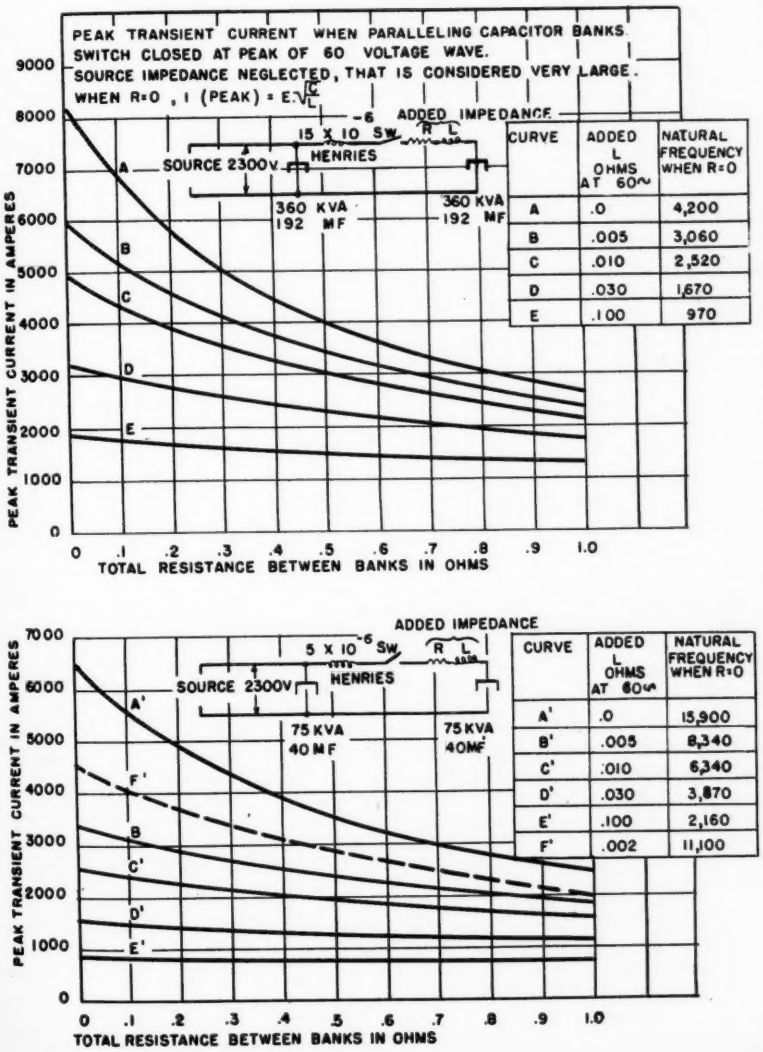

PEAK TRANSIENT CURRENT WHEN PARALLELING CAPACITOR BANKS.
SWITCH CLOSED AT PEAK OF 60 VOLTAGE WAVE.
SOURCE IMPEDANCE NEGLECTED, THAT IS CONSIDERED VERY LARGE.
WHEN R=0 , I (PEAK) = E √C/L
ADDED IMPEDANCE
15 X 10 -6 SW.
R L
HENRIES
SOURCE 2300V
360 KVA
192 MF
360 KVA
192 MF
CURVE | ADDED L OHMS AT 60~ | NATURAL FREQUENCY WHEN R=0
A | .0 | 4,200
B | .005 | 3,060
C | .010 | 2,520
D | .030 | 1,670
E | .100 | 970
PEAK TRANSIENT CURRENT IN AMPERES
TOTAL RESISTANCE BETWEEN BANKS IN OHMS
ADDED IMPEDANCE
5 X 10 -6 SW.
R L
HENRIES
SOURCE 2300V
75 KVA
40 MF
75 KVA
40MF
CURVE | ADDED L OHMS AT 60~ | NATURAL FREQUENCY WHEN R=0
A' | .0 | 15,900
B' | .005 | 8,340
C' | .010 | 6,340
D' | .030 | 3,870
E' | .100 | 2,160
F' | .002 | 11,100
PEAK TRANSIENT CURRENT IN AMPERES
TOTAL RESISTANCE BETWEEN BANKS IN OHMS

Fig. 10. Maximum capacitor inrush current when one bank of 230 v capacitors is switched in parallel with another already energized

In this test one must use a transformer large enough to supply the current that will be drawn by the capacitor. A 15 kva unit will draw 15 kva at rated voltage and 46 kva at 175 per cent voltage. It may be desirable in most cases to use rated voltage if this is merely a check test to select a bad unit from a group, and if there is no convenient way of raising the voltage to 175 per cent. Rated voltage may be applied directly, while if 175 per cent is applied it must be raised from the rated voltage value by suitable means which will give reasonable wave form. This *excludes* the use of variable resistance in the primary of the testing transformer.

It will be obvious from the above that a conventional insulation test box cannot be used for such tests, because the breaker will trip out upon connecting the capacitor due to high burden.

This test may be interpreted as follows:—

(a) Blowing of the fuse indicates a shorted capacitor. Arcing inside of the capacitor indicates that some of the sections are shorted.

Absence of current indicates that the capacitor is open circuited.

(b) Normal current or current up to 115 per cent of normal indicates that the capacitor is in good condition.

Normal current can be calculated by the method outlined previously.

(c) Current in excess of 115 per cent of normal indicates either some of the series sections are shorted out, or that there are harmonics in the supply voltage. Capacitors rated at 1500 v or above contain series sections. If the wave form of the test voltage is questionable, capacitors drawing an excess current should be rechecked for capacitance on another circuit, as for example a 230 v lighting circuit, observing the voltage and current.

(d) Current well below normal indicates a damaged capacitor.

(e) In testing 3 phase units, short one phase and test between this jumper and the other terminal. This applies tests to ⅔ of the capacitor. Repeat until three such tests are made, first shorting A to B, then B to C, and finally A to C. Expected normal current values are 66⅔ per cent of the values for single phase unit.

(f) While it is not often needed, the actual value of capacitance in each phase of a 3 phase delta connected unit can be measured as follows:

(1) Connect 1 and 2 together, Fig. 4, and test between this point and 3, using a known voltage. Calculate MF which will be the sum of B and C.

(2) Connect 1 and 3 and test to 2 to find capacitance of A + C.

(3) Find A + B in the same manner.

(4) Then $A = (A + B) + (A + C) - (B + C) \times ½$

$B = (A + B) + (B + C) - (A + C) \times ½$

$C = (A + C) - (A + B) + (B + C) \times ½$

Seventh Annual Water Conference Pittsburgh, Pa., January 6-8

EACH succeeding year the Annual Water Conference conducted under the chairmanship of H. W. Olson by the Civil Section of the Engineers' Society of Western Pennsylvania in Pittsburgh has grown in attendance and interest. The seventh of these conferences was extended from two days as formerly conducted to three days—January 6, 7 and 8. Postponement from October 28-30, 1946, the dates originally set for the conference, apparently did not detract from the value of or interest in the meeting for the entire program was carried through with dispatch and the registration of over 300 was the largest that any of the water conferences has attained.

Papers presented at this conference were prepared by water chemists and dealt with many phases of water treatment for industrial and household uses which are being studied throughout the country. In the first paper on the program W. W. Cerna of Hall Laboratories reported on an investigation made in 1945 of the water conditioning services and systems of the German power industry. There he found, basically, the various methods of water conditioning the same as those in the United States. Among recently introduced variations, however, were what is known as the Wofatit group of synthetic resins with exchange properties. Wofatit P treatment was used for final softening at temperatures as high as 210-212 F, following hot process precipitation type softeners.

An endpoint indicator for determining dissolved oxygen in water was described by R. C. Ulmer of E. F. Drew and Co., Inc. This commercially available apparatus uses a 6E5 magic eye radio tuning tube. The endpoint is indicated by the closing of the eye and the sensitivity of the endpoint determination is about 0.002 ppm of dissolved oxygen.

Steam Quality

Improvement of steam quality was discussed by Arthur L. Jacoby and W. H. Thompson both of National Aluminate Corp. It was stated that wet steam is due to carryover which may be caused by slugs or splashing, aquaglobejection, and foaming. Most of the discussion involved the causes and prevention of foaming. Foam may be stabilized by soluble, colloidal, and insoluble materials. The mechanism of stabilization was discussed for each of these classes of materials. A theory of antifoam action was presented, and recently developed antifoam materials comprising certain polyamides were described.

Closely related to the steam quality discussion were the findings of an investigation of carryover problems and identification of types of carryover reported by P. B. Place of Combustion Engineering Co. He classified four common types of carryover as (1) priming, (2) foamover, (3) spray, and (4) leakage and stated that it is desirable to identify the type of carryover involved to facilitate correction of the trouble.

These types of carryover are affected to different degree by changes in mechanical, water, and operating conditions and we may identify the type of carryover by determining the effect of these various changes. He stated that if high water levels, atomization of boiler water, and formation of foam films did not develop in a boiler, we would not have priming, spray carryover, or foamover. On the other hand, all three of these sources may be present without causing actual carryover. Carryover problems develop when these sources of carryover exceed the limit of the drum internals to control them.

Turbine Blade Deposits

Among the most troublesome operating problems today is that due to silica deposits in steam turbines which was discussed by F. R. Owens of Cyrus Wm. Rice. He presented plant and laboratory data which showed that the silica concentration in a water may increase by softening through natural zeolite. This increase, he said, is a function of temperature, growth of organic organisms, the number of regeneration cycles, hydrogen ion and total ion concentration of the water. Evidence of a change in molecular structure of silica as a result of superheating saturated steam is shown through colorimetric (electrophotometer) determinations. As a result the author subscribes to the theory of selective vaporization of silica.

Operators who must contend with these deposits were benefited by a description of a chemical method for removing silica from turbine blades, presented by D. Forty, Public Service Co. of Northern Illinois. He described the problem as one confronting the operators of steam generating stations using steam pressures over 800 psi. The deposits in the lower stages of the expansion cycle have been hard and insoluble in water necessitating the use of some other means of cleaning than had been normally used with the water soluble deposits. Dismantling and cleaning by blasting with an abrasive is reported as expensive and during the war the system load demands often made it imperative that the turbine be kept in service.

Where conditions are such that the silica in the boiler water cannot be controlled, the author advised resort to a chemical cleaning method which does not require dismantling of the turbine and reported on experiments made using a sodium hydroxide solution injected in to the steam at low turbine speeds and a steam temperature slightly above saturation which proved to be effective.

Symposium on Silica Removal

Silica removal by ion exchange was the topic of a symposium at which speakers from several companies specializing in this type of water treatment explained their methods. W. W. Jukkola and R. B. Thompson of Dorr Co. described methods of applying the Fluoride process in conventional de-ionization equipment. In the cyclic process outlined fluorides are covered and used over again.

M. E. Gilwood, of Permutit Co. stated that a variety of different methods for removing silica from water are available. Before deciding which treatment should be recommended for a given boiler plant, it is necessary in each case to make a complete engineering economic study to determine which process results in the most economical over-all boiler and water plant operation.

W. C. Bauman of the Dow Chemical Co. reported that the complete removal of silica from water has been attained with ion exchange resins. Silica is converted to fluosilicic acid and removed as such by an anion resin. Three methods of fluoride addition for silica removal and six different anion resins were used in the study. Alkali regeneration of exhausted anion beds must be preceded by acid or salt treatment to avoid precipitation of silica in the anion exchangers.

W. S. Morrison of Illinois Water Treatment Co., described a method that is used to remove silica in a water from 8.5 ppm down to an effluent concentration of not more than 0.2 ppm SiO_2, by using an anion and cation unit placed in series at a flow rate of 300 gpm.

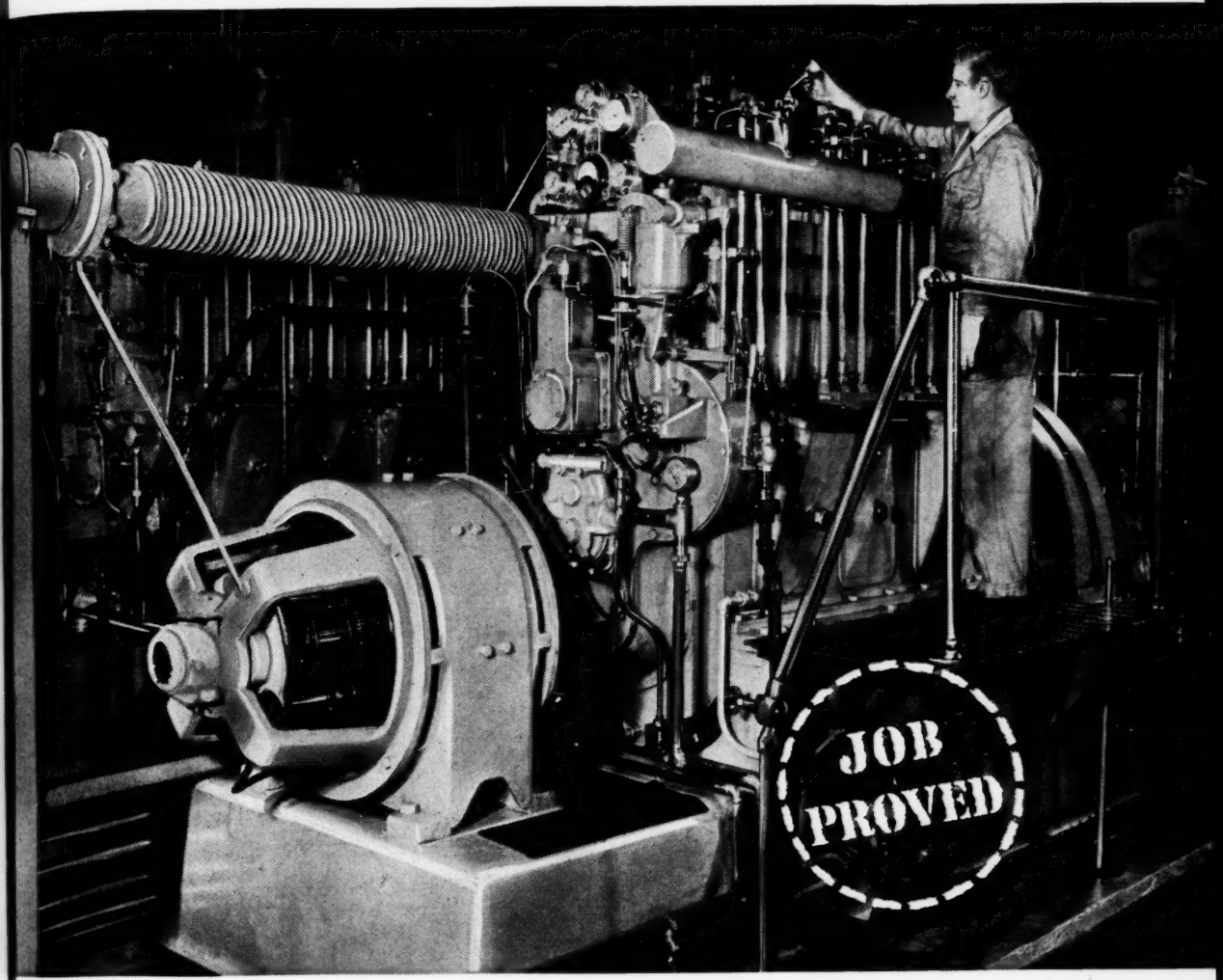
Gases in Water

Effects of gases in water were discussed by T. E. Larson of the Illinois State Water Survey Division, who gave the source and effect of some twenty gases which may be found in water, particular attention being given to carbon dioxide.

In his discussion of iron and manganese removal, S. P. Applebaum of Liquid Conditioning Corp., stated that no single method is satisfactory for this purpose. Hard waters low in organic matter, and containing medium amounts of iron and manganese can be handled by simple pressure aeration and filtration. But when the water is low in hardness and contains high amounts of CO_2 or organic matter, it is necessary to precede the final filters by contact filters and frequently chemical pretreatments are required in addition.

Clarification of Industrial Wastes and Wasted Efforts was discussed by Harold R. Hay of Philadelphia Quartz Co.; Current Trends in the Re-use of Water by Charles F. Hauck of Hall Laboratories; Applications of Ion Exchange by M. J. Shoemaker of Research Products Corp.; and Ion Exchange in the Treatment of Wastes by A. B. Mindler and M. E. Gilwood of the Permutit Co. of New York, N.Y.

Two Years Without Repairs, Replacement or Overhaul



SUN DIESEL LUBRICANT . . .

Keeps Two Diesels in Perfect Condition and Puts an End to Frequent Overhauls

A municipal plant which uses two 125-horsepower Diesels for pumping was confronted with a serious lubrication problem. Oil was forming sludge with the result that frequent shutdowns and overhauls were necessary.

A Sun Engineer was called in and after careful analysis recommended a Sun "Job Proved" oil specially refined to stand up under the particular operating conditions.

With Sun oil in the crankcases, the engines were kept in regular service for more than two years. Sludge disappeared. Oil consumption dropped. Mechanical repairs, replacements and overhauls were reduced to practically nothing. There was no excess carbon formation.

The ability to solve problems like this is typical of "Job Proved" products and of Sun Engineers. Wherever you have a tough problem involving petroleum products, whether in Diesel engines, turbines, gas or gasoline equipment, call your nearest Sun office or write Department PP3.

SUN OIL COMPANY • ***Philadelphia 3, Pa.***

SUN

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INDUSTRIAL PRODUCTS

Handling Oil In TVA Hydroelectric Plants

How governor and lubricating oils are specified, stored, pumped and cleaned. Separate purification system in each plant for insulating oil used in transformers, circuit breakers, other electrical equipment. Oil for runner hubs of Kaplan turbines salvaged when runners are inspected or repaired.

By H. J. PETERSEN
Head Mechanical Engineer, Tennessee Valley Authority

THE AUTHORITY uses the same oil for the governor pressure system and for the lubrication of the generator thrust bearing. Some difference of opinion between the governor and generator manufacturers has arisen lately over the viscosity of this oil. The generator manufacturers prefer an oil with a viscosity in excess of 300 S.S.U. at 100 F, while the governor manufacturers prefer this viscosity to be around 250 S.S.U. at 100 F. In order to avoid the necessity of two separate oil systems, oil with a viscosity of 300 S.S.U. at 100 F will be purchased in the future.

We have found that purifying oil by centrifugal force is satisfactory and economical, and we have standardized on that type of machine. A self-contained and enclosed stationary 350-gph unit, complete with centrifuge, motor, pump, electric heaters, temperature control, and all standard accessories, is purchased for each plant. In the early stages of the Tennessee Valley Authority program consideration was given to the use of a portable machine which could be transported to individual plants as required. A central purifying depot, where oil from all plants could be shipped for processing, was also considered. These were both ruled out because of operating inconveniences involved and because the cost of a purifying system is a very small percentage of the total cost of each plant.

Two tanks are provided for each project, one for clean oil and one for dirty oil. Each tank has sufficient storage for the oil in one unit thrust bearing, plus the oil in one governor system, plus a few hundred gallons of extra capacity. When space permits, these tanks are located in the powerhouse adjacent to the oil-purification room. In plants where no space is available the tanks are buried in the fill outside the powerhouse wall. Tanks placed in this manner are designed with an extra 1/16 in. of metal to allow for corrosion. In either case the storage tanks are always located so that they may be filled by gravity from the ground level and still provide a positive head on the pumps.

One clean-oil pump and one dirty-oil pump are furnished for each powerhouse. The pumps are standard positive-displacement type with built-in relief valves and are rated 30 gpm when pumping oil at 50 F. A complete piping system is installed at each plant between the units and the purification facilities. The Authority uses black steel, scale-free uninsulated pipe for these oil lines. Experience has proved that it is difficult to prevent leaks in piping using screwed malleable fittings, especially when the oil is hot, as around the centrifuge. Consequently welded joints are used throughout, except at valves and unions, with forged-steel-socket welding fittings used for sizes 2 in. and smaller. Oil-resistant gaskets are used when it is necessary to use flanges. No matter how well a pipe line is cleaned, there will always be scale and welding particles carried along in the oil, especially when starting the system. For this reason a filter is installed in the line leading to each unit and a standard Y-type strainer with 1/32-in. perforations is used on each pump suction. These filters have 0.005-in. openings through metal slots and are equipped with built-in knife-blade cleaners.

Insulating Oil

Because of its different characteristics from lubricating oil, a separate oil-purification system is installed in each plant for the insulating oil used in the transformers, circuit breakers, and other oil-filled electrical equipment. The same type of machine is used as just described, but because of the larger volumes handled, its capacity is increased to 600 gph. A filter press which raises the purifying capacity to 900 gph is added to this machine to remove the colloidal carbon from the oil.

One clean-oil pump and one dirty-oil pump are installed in each plant. They are of the same type as the pumps for the lubricating-oil system, with the capacities increased to 100 gpm each. At some plants it is possible to return the dirty oil from the switchyard to the storage and purification rooms by gravity, and no dirty-oil pump is supplied. One clean-oil tank, one dirty-breaker-oil tank, and two dirty-transformer-oil tanks are provided at each plant. In this way the breaker oil and transformer oil are never mixed after they once have been used. Each of the circuit-breaker-oil tanks (clean and dirty) has storage capacity for one breaker, and the two dirty-oil transformer tanks have a total storage capacity for one transformer.

The same comments apply for the piping as for lubricating oil, except that black wrought iron is used for underground lines in the switchyard. The supply and return lines in the switchyard are not permanently connected to the transformers and breakers; instead, a valve is located in each line near the equipment and a flexible hose is used when filling or draining is necessary. This hose has a specially treated synthetic-rubber lining and is equipped with a flexible ball-joint fitting to facilitate attachment to the service valve. Because the oil is changed at infrequent intervals we find this arrangement entirely satisfactory.

Runner-Hub Oil

In the main river plants which have Kaplan turbines the runner hub is filled with a heavy oil for lubricating the internal blade-operating mechanism. This oil has a viscosity of approximately 1700 S.S.U. at 40 F. Whenever the runner is dismantled for inspection or repair, it is necessary to remove this oil, and since there are approximately 1500 gal of oil in each hub, the Authority salvages it for reuse.

A black-steel pipe header is installed in the access gallery located below the units in each plant. Branch headers lead from this line to the draft-tube access doors of each unit, and connection to the hub is made with a flexible hose. An 8-gpm motor-driven screw-type portable pump and two portable storage tanks are provided for transporting and storing the oil during the dismantling of the unit. Because of the infrequency of this operation, the storage tanks and the pump were made portable so that they may be transferred from plant to plant as required. Two storage tanks were supplied to reduce the volume of each tank to facilitate handling.

From a paper entitled Design of Mechanical Auxiliaries for TVA Hydroelectric Plants, presented before Spring Meeting, ASME, Chattanooga, Tenn., April 1946. To be published in full in ASME Transactions.

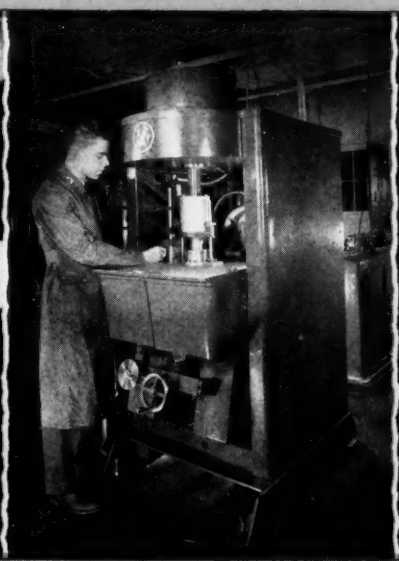
AN EDWARD CONTRIBUTION TO BETTER VALVE PERFORMANCE — EVALIZING

how EVALIZING CHANGED AN ANCIENT FEUD INTO A BEAUTIFUL FRIENDSHIP

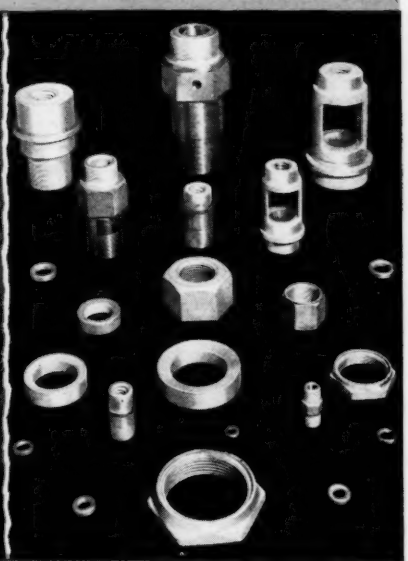
STEEL RUBBING AGAINST STEEL, such as a valve stem rotating in a valve bonnet, has often resulted in trouble — galling, freezing abrasion or wear that reduced valve life and increased maintenance.

And then Edward developed *EValizing* to the immediate and lasting benefit of Edward valve users.

An easy hand test shows how silken-smooth and frictionless is this contact of bonnet and stem with the bonnet threads EValized.



In high temperature tests duplicating actual operation, valve stems have been rotated through EValized bonnets 5000% more than regular bonnets.



Edward EValises many valve parts — bonnets, junk rings, packing nuts, bearing plates, and nuts for large valve body-bonnet bolting.

EValizing is an exclusive process for coating steel parts with abrasion resistant bearing material.

EValizing reduces friction between moving steel parts by approximately 50 per cent—it practically eliminates galling and freezing where parts must slide or turn freely in contact with other steel parts.

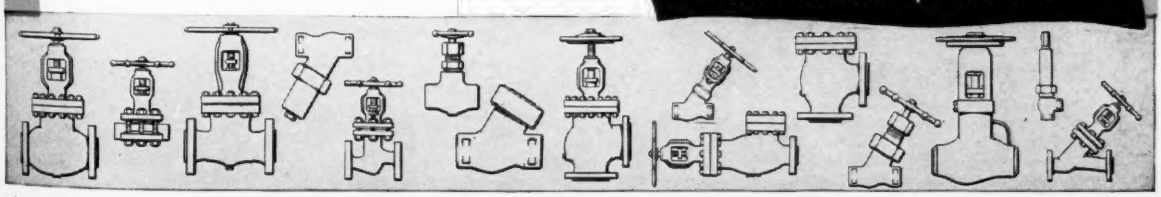
EValizing, developed for gall resisting qualities, also fights corrosion.

EValizing is another Edward contribution to better valve performance.

Edward Valves, Inc.

Subsidiary of Rockwell Manufacturing Company

EAST CHICAGO, INDIANA



Protection of Powerhouse Auxiliaries

A report on systems of protection used for power plant auxiliaries used by various utility companies throughout the United States, made by the Relay Subcommittee of the American Institute of Electrical Engineers. This report was presented before the American Institute of Electrical Engineers Convention at Detroit in June

THE PROTECTION of electrically driven powerhouse auxiliaries is important because the operation of the plant as a whole depends upon the auxiliaries and unless the auxiliaries can be kept running the plant has to shut down. Some time ago the Relay Subcommittee of the American Institute of Electrical Engineers made a detailed study of the whole question of protection of generating station auxiliary power motors and supply systems. The study was made to obtain information on auxiliary power systems now in use and the protective methods being applied, and to make recommendations on preferred practices.

In order to obtain basic information, a questionnaire was sent to a number of engineers interested in this subject. These questionnaires covered data on the supply systems used, various forms of protection applied, and a summary of the experience obtained with these systems. Answers to the questionnaire were received from various representative companies covering both steam and hydro stations and a wide range in station sizes. The answers submitted represented the modern practice of each company.

Summary of Information Received

Following is a brief summary of the information received on the various points covered by the questionnaire:

(a) Supply Systems Used

In most cases, transformers are being used for auxiliary power supply. 2300 and 440 v are the principal voltages used, with motors above approximately 100 hp being supplied by the higher voltage system. In most cases, the systems operate ungrounded, although some companies prefer to operate grounded, either solidly or through impedance.

The protection of the auxiliary power transformers includes, in most cases, differential relays with time delay overcurrent protection for back-up purposes. In many installations, there are two sources of primary supply with an automatic throw-over arrangement, initiated by undervoltage relays, which connects the reserve supply if the primary source is lost.

On buses supplied by auxiliary generators, the problem of bus protection is complicated by the decrement in fault current supplied by the generator. The decrement causes a rapid reduction of fault current to a point approaching normal load current, so that it is difficult to obtain bus protection with time-delay overcurrent relays. In such cases differential or fault bus relays provide the most desirable method for bus protection.

(b) Motor Protection

In the majority of cases, the 2300-v motors are protected by long-time-delay overload relays set at 125 per cent to 150 per cent of full load current and instantaneous overcurrent relays on the cable leads which are set above the starting inrush current. The smaller motors are in general protected by thermal tripping elements for overload, and an instantaneous trip device for short circuits.

There is some variation in the treatment of essential and non-essential motors. In most cases, the essential and non-essential motors are protected by similar relays. However, in a few cases the circuit breakers feeding essential motors are not tripped by the time delay overload relays. These relays give an alarm only in the event of an overload condition.

Essential motors are defined as those motors whose failure results in the shutdown of generating capacity. Examples of this class of motors include the circulating pump, boiler feed pump, and induced forced draft fans.

(c) Other Forms of Protection

In most cases where the systems are operated ungrounded, ground detectors are available for detecting grounds.

In powdered fuel plants, it is necessary to interlock the sequence of starting and stopping certain motors. For example, the induced draft fan is started first, and is followed in sequence by the forced draft fan, the exhauster, the pulverizer, and the feeder. If any piece of equipment in this series is stopped, provision is made to stop automatically all of the motors ahead of it.

(d) Experience and General Conclusions

The answers received indicated that as a whole, the protective schemes now in use are satisfactory. The only indication of unsatisfactory performance has been with the thermal relays used on the smaller motors. Various types of troubles have been reported, such as lack of thermal capacity to withstand fault currents, and lack of sensitivity. One company uses oversize thermal elements to avoid difficulties which have been experienced with the sizes recommended by manufacturers.

In general, the importance of auxiliary

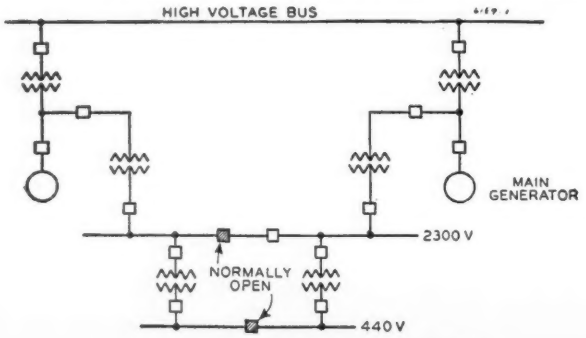


Fig. 1. The supply system used by company No. 2

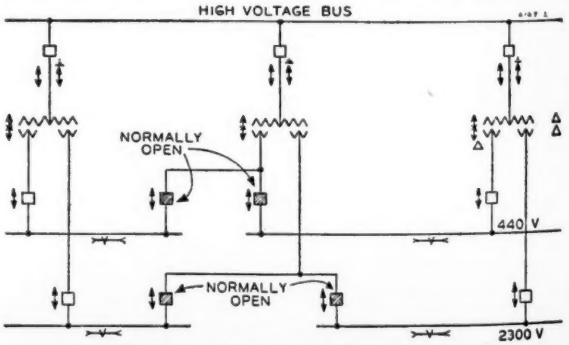


Fig. 2. The supply system used by company No. 3

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3. **Laboratory service for scientific examination of all samples.**
4. **Development of a complete system of treatment and control.**
5. **Instruction of operating personnel in application of the treatment system and control procedure.**
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power in generating stations is so fundamental that simple and rugged relaying schemes are to be desired. In almost every case the auxiliary power supply is the last element of the system which should be shut down and therefore the relaying systems used should be as free from trouble as possible.

Recommended Preferred Practices

(a) SUPPLY SYSTEMS

(1) For ungrounded systems or grounded systems where the ground fault is limited to a few amperes, ground detector relays should be used.

For systems grounded solidly or through low impedance, residual current relays should be used on individual circuits.

(2) Transformers supplying essential auxiliary power buses should be protected with differential relays, and time delay overcurrent relays should be used for back-up protection.

(3) Bus protection should be provided by overcurrent differential, or fault bus relays. Overcurrent relays on auxiliary generators should not be relied upon for bus protection.

(b) MOTOR PROTECTION

(1) 2300-v motors. Use long time-delay phase overcurrent relays for overload and internal motor faults set at approximately 150 per cent of rated current. Also instantaneous overcurrent relays for shirt-circuit protection set above maximum inrush current.

On essential motors the time-delay overload relays may be used for alarm purposes only, and the instantaneous relays used to trip. In this case, the time-delay relays can be set more sensitively than 150 per cent of rated current.

(2) Low-voltage motors (208v, 440v, 550v, etc.). Use thermal device for overload protection, and an instantaneous trip device for short-circuit protection.

The thermal device may be built into the contactor supplying the individual motor, and one circuit breaker may provide short-circuit protection for a group of motors.

On essential motors the thermal element may be used for alarm purposes only.

Answers to Questionnaires

A few typical individual answers to questionnaires are as follows:

Company No. 1

A. *Supply Systems Used.*

This company uses transformers for supplying power to 2300 and 440 v buses. The transformers are operated ungrounded.

B. *Motor Protection.*

Motors of 75 hp and above are 2300 v. These motors have long time-delay induction overload relays set at about 150 per cent of full load. Instantaneous relays are also used and are set to just exceed the maximum starting inrush current.

The 440-v motors are all protected by circuit breakers with thermal tripping elements.

C. *Other Forms of Protection.*

Static type ground detectors or lamps are used to detect grounded circuits, which are located by opening the circuits in turn.

Most essential auxiliaries are equipped with dual drive.

Both 2300 and 440 v buses are arranged for automatic throwover to adjacent sections in case of loss of potential although the throwover will not function in case of a fault on the bus. Throwover is initiated when the voltage drops to about 6 per cent.

D. *Experience.*

As a whole the protection has been satisfactory.

E. *General Conclusions.*

We feel that the ideal type of auxiliary power motor protection would consist of an instantaneous relay sensitive to all motor faults but insensitive to overloads, plus an overload relay with good correlation between its operating characteristic and motor temperatures.

Company No. 2

A. *Supply Systems Used.*

This company uses transformers for supplying power to 2300 and 440-v buses as shown in Fig. 1. The transformers are operated ungrounded. The transformers are protected by overall differential relays with time delay overcurrent protection on the low voltage output and time delay, phase and instantaneous ground protection on the primary.

B. *Motor Protection.*

Motors 75 to 100 hp are supplied at 2300 v. On 2300-v "Essential" motors, the protection consists of instantaneous overcurrent plunger relays for short circuit protection. Thermal relays give visual indication only. On "Non-Essential" motors, the protection consists of 40-second overcurrent induction relays with instantaneous attachments.

On 440-v "Essential" motors, the protection consists of small instantaneous air circuit breakers. Thermal elements of motor contactors light lamp only. The "Non-Essential" 440-v motors have the same protection except that the thermal elements trip motor.

C. *Other Forms of Protection.*

Ground detector relays are used on the 2300-v system and lamps on the 440-v system.

An interlocking system between motors is used on the boiler auxiliaries to protect boiler against motor failures.

D. *Experience.*

The reliability of modern motors justifies minimum of protection and maximum freedom from undesired tripping.

Relays for 2300-v breakers are satisfactory, but contactor elements, small air circuit breakers, etc. for 440-v service are not sufficiently reliable.

Many applications require "latched-in" contactors to prevent disconnection on voltage surges.

Company No. 3

A. *Supply Systems Used.*

The supply system is that illustrated in Fig. 2.

B. *Motor Protection.*

Motors up to 125 hp are connected to 440-v bus.

All 2300-v motors are protected by differential relays using instantaneous overcurrent relays set for approximately 50 per cent of full load current.

On the 440-v system, feeders from the main bus are used to supply sub-buses throughout the plant. These feeders use circuit breakers with a series trip set for 200 to 400 per cent of the rating of breaker. These breakers pro-

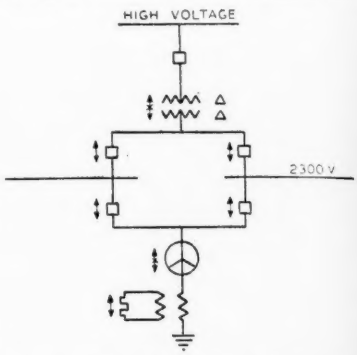


Fig. 3. The supply system used by company No. 6

tect for faults on the sub-buses and heavy faults on the feeders to the 440-v motors. Each motor is individually protected by a contactor with thermal relay set for 30 seconds at 150 per cent load.

C. *Other Forms of Protection.*

Lamps are used for ground detecting system. Grounds are removed by disconnecting portions of the system until the ground is located. The location of grounds is delayed until it is convenient to take equipment out of service.

D. *Experience.*

High speed clearing of faults has resulted in very satisfactory operating conditions and has proved advantageous in limiting the extent of damage due to motor faults.

Lack of thermal overcurrent protection on 2300-v motors has resulted in some difficulty with detecting cases of overload on mill motors.

Operation of thermal elements on 440-v motors has been satisfactory.

E. *General Conclusions.*

While differential protection on 2300-v motors has proved to be advantageous it is questionable whether their use is economically justifiable. Future installations will use overcurrent relays.

Company No. 4

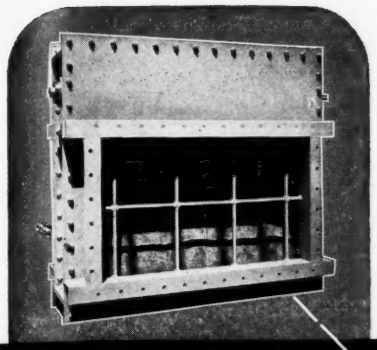
A. *Supply Systems Used.*

The supply to auxiliary power is from transformers 13.8/2.3 kv Delta-Wye connected. The 2.3 kv neutral is solidly grounded. Smaller motors are supplied from a 575-v system, which in some cases is grounded and in other cases ungrounded. The transformers are protected by differential and induction type overcurrent relays.

B. *Motor Protection.*

Motors up to 100 hp are supplied from the 575-v system.

Motors are protected by a 40-second



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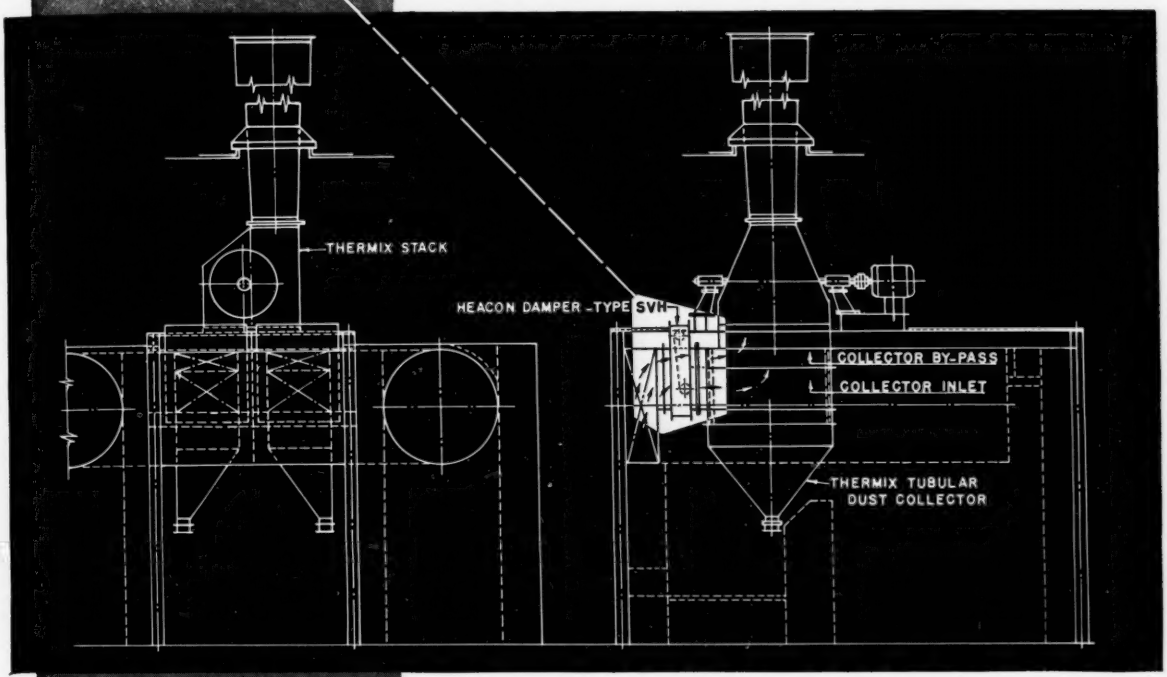

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induction type relay with instantaneous attachment. The time delay element is set at approximately half way between motor full load temperature curve and the curve representing motor thermal limitations. The instantaneous trip is set just over "locked rotor" current. In some instances, thermal relays are used which are set in the same manner as for the induction relays.

No distinction is made between methods employed for protection of essential and non-essential motors except in the case of instantaneous auxiliary overcurrent relays set at approximately 115 per cent full rated current applied to pulverizer motors for stopping coal feeder motors until the pulverizer motor current drops back to normal.

C. *Other Forms of Protection.*

Very elaborate interlock systems between induced and forced draft fans, pulverizers, boiler feed water pumps, etc.

Ground lamps are used for ground protection. No grounds have developed to date.

D. *Experience.*

Performances of protective and control schemes have been excellent. All thermal relays of a certain make have had to be dismantled and reassembled in our laboratory before being placed in service due to poor factory jobs.

Speeds of clearing faults have been very satisfactory, and all cable and motor fault currents have been of a magnitude high enough to operate the 1-cycle relays. Iron and winding damage have been negligible.

E. *General Conclusions.*

The simplicity of the 40-second induction overcurrent relays with instantaneous current trip features makes this scheme a slight favorite over the thermal combination for 2.3 motors. The manufacturer's standard protection on 575-v cubicle switch-gear has been found satisfactory.

Company No. 6

A. *Supply Systems Used.*

A 440-v system is used which is fed from either of the 2300-v buses.

B. *Motor Protection.*

On motors fed from the 2300-v service long time CO relays with instantaneous elements are used. Long time CO's having a time delay up to 40 seconds are used and can be set for 110 to 125 per cent of full load current and with sufficient time delay to ride over the starting inrush. The instantaneous elements are set above starting inrush and furnish protection for faults on motor leads and circuit.

The main 440-v motors are equipped with individual ITE Co. circuit breakers with thermo magnetic overload protection. This provides both overload and short circuit for these motors. Time delay under voltage CV relays are used on the 2300-v motors.

C. *Other Forms of Protection.*

Automatic transfer of buses from the transformer to the generator source is provided to transfer load in case of voltage failure. The transfer scheme is interlocked to prevent paralleling of buses or to transfer after an overload relay operation.

The 440-v buses have automatic transfer between transformers connected to the two 2300-v bus sections and have interlocks similar to the 2300-v buses.

D. *Experience.*

The protective schemes used have given very satisfactory service and no load curtailment or shut down has occurred due to station service failures. The equipment described is new and few failures have occurred.

E. *General Conclusions.*

The long time CO relays with instantaneous attachments seem to offer satisfactory protection for the 2300-v motors since they can be set low enough to prevent roasting of insulation on overload and the instantaneous elements provide quick clearing for severe faults.

Recent Gas Turbine Developments at Brown Boveri

By PAUL R. SIDLER President, Brown Boveri Corporation, New York

IN THIS article some of the latest gas turbine developments at Brown-Boveri & Co. Ltd. in Switzerland will be discussed, but before going into the details of our most recent gas turbine work, let us review briefly the status of some of the older gas turbine sets.

The 4000-kw Neuchatel turbine set (POWER PLANT ENGINEERING, March 1944) continues as stand-by and peak-load unit. It is operated for a few hours every week to keep it in good running condition and also to keep the attendants in practice. Now that fuel oil is again more freely available in Switzerland, it can also be started up and run for interested visitors.

Mobile Power Plant

In the general field of mobile power plants designs have been developed for a 4400-kw power plant on wheels as shown in Fig. 1. The overall length is about 88 ft—one car length—as compared to the 4-6 car trains needed for a mobile steam power plant of comparable capacity.

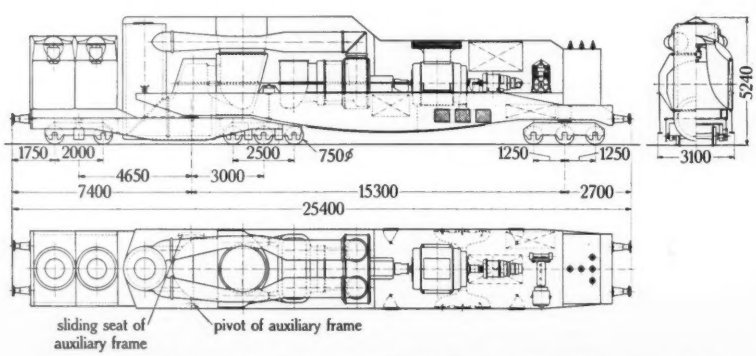

Fig. 1. Proposed layout for mobile self-contained 4400 kw gas turbine power plant

Two 4000-kw Sets

In November, 1945, gas turbine units in sizes from 1200 to 10,000 kw and for various applications were on order with Brown Boveri. Two additional sets, each for 4000 kw, natural gas fired and intended for an oil refinery in Southern Iran were added shortly thereafter. In the intervening months, work on these units has proceeded and the first sets are now being tested or come very close to that stage. Test runs on the 10,000-kw set for Filaret Power Station, near Bucharest, Rumania were started in the latter part of April, 1946.

(Editor's note: In his original paper Mr. Sidler described in considerable detail the gas turbine locomotive work done by Brown Boveri, and its present status, but we have omitted it in this presentation.)

10,000 kw Stand-by Unit

This stand-by and peak-load unit is set-up with two pressure stages, an intercooler between the two compressors, also with two combustion chambers

From a paper presented before the ASME Oil and Gas Power Conference, Milwaukee, Wis.

Photo courtesy Northern Pacific Railway Company.

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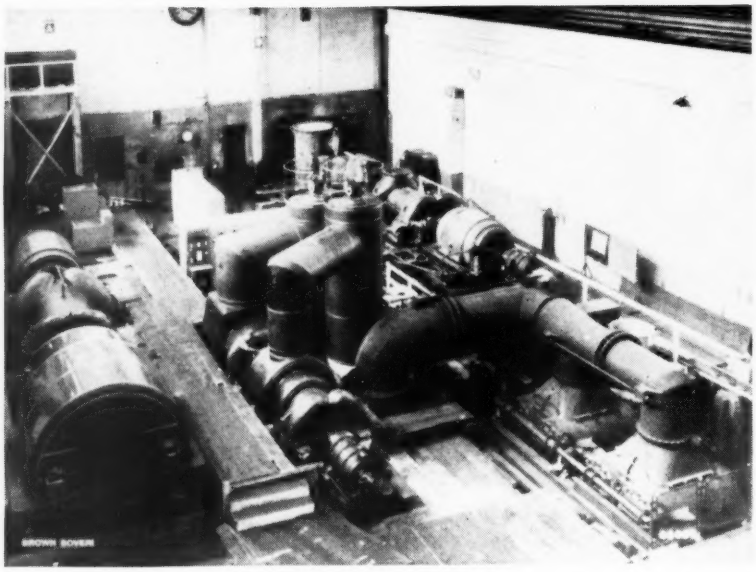

Fig. 2. 10,000 kw gas turbine power unit for Filaret, Rumania assembled for test. LP unit is shown at left, HP unit with two combustion chambers in center, and intercooler between two compressors in lower right hand corner. To the right, and behind the two combustion chambers, the 4000 kw gas turbine set for Chimbote, Peru, is being assembled

(reheat) but without an air-preheater. The generator designed for 12,500 kva, 80 per cent power factor, 5300 v, 50 cycles, is directly coupled to the low-pressure turbine compressor, operating at 3000 rpm. This arrangement results in low cost but also in relatively low efficiency, as is entirely fitting for stand-by power plants. The two turbo-compressor sets are placed closely together, in parallel, to avoid excessive axial length.

An overall view of this set, completely assembled for tests is given in Fig. 2. The low-pressure set is located on the left, with the gas turbine in the foreground, followed by the compressor, the generator and not too clearly visible, the starting motor and the exciter. In the center appears the high pressure set, with starting motor, compressor and gas turbine, also showing the pipe connection to the combustion chambers, HP in front and LP behind it. In the lower right hand corner will be observed the two sections of the intercooler for air, inserted between the two compressor stages. In the actual installation, this equipment will be located in the basement, below the gas turbine sets.

In the upper right hand corner another gas turbine set, the 4000 kw peak-load unit for Chimbote, Peru, is shown partly assembled. Tests on this further power plant have also started in the meantime.

Fig. 3 gives a close-up view of the low-pressure compressor with the generator to the left and the gas turbine to the right. The speed governor will be seen just in front of the compressor housing. The two combustion chambers appear just behind this set.

A large series of tests were carried out with this unit, to check starting characteristics and operation over the entire load range, with the generator connected to a variable water resistor. These tests showed particularly a good overload capacity, reaching a maximum of 12,000 kw with an air inlet temperature of 68 F and a maximum continuous gas inlet temperature of 1112 F.

The guaranteed thermal efficiencies for natural gas fuel and referred to the generator coupling were:

At	4/4	3/4	2/4	1/4	load
	22	20	16	9	%

The tests showed one point higher efficiency at all loads, namely

23	21	17	10	%

The set required about four minutes to start from stand-still up to full speed. There is no need for extended warming-up periods, a rather important feature for stand-by and peak-load service. When full speed is reached, the additional time required to get full load was another 3½ min. as the water resistor could not take on the load faster. In the actual installation where load demands may build up more quickly, the turbine could also readily follow this higher speed.

Shutting Down Time

Also, the shutting down time is not longer than customary for steam turbines. Once the fuel gas is shut off, cooled air flows through the system while the set is running down slowly. If it is desired to cool down more rapidly, the units could be rotated at about half speed or 1500 rpm by switching in the two starting motors when the set is slowed down to this speed. The ignition speed of the sets is in the neighborhood of 800 rpm but the starting motors are designed to run up to 1500 rpm (4 pole design) if this is found desirable under any operating conditions. One such occasion is the rapid cooling down.

The usual large number of starting and shutting down operations were carried out without any disagreeable surprises. These transient conditions are of course, the most severe. During all these tests, the units showed no vibration and produced the same sound level as is customary for steam turbines.

It is hoped that these remarks will have shown that gas turbines for commercial uses are a practical reality now. This new prime mover has a number of applications in many fields now and its use need not be delayed until new alloys permitting higher temperatures are commercially available.

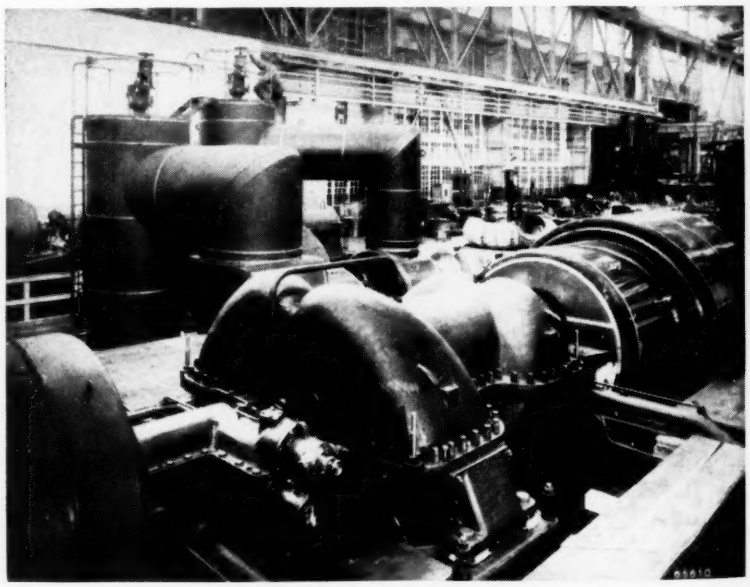

Fig. 3. Close up view of LP compressor shown in Fig. 2

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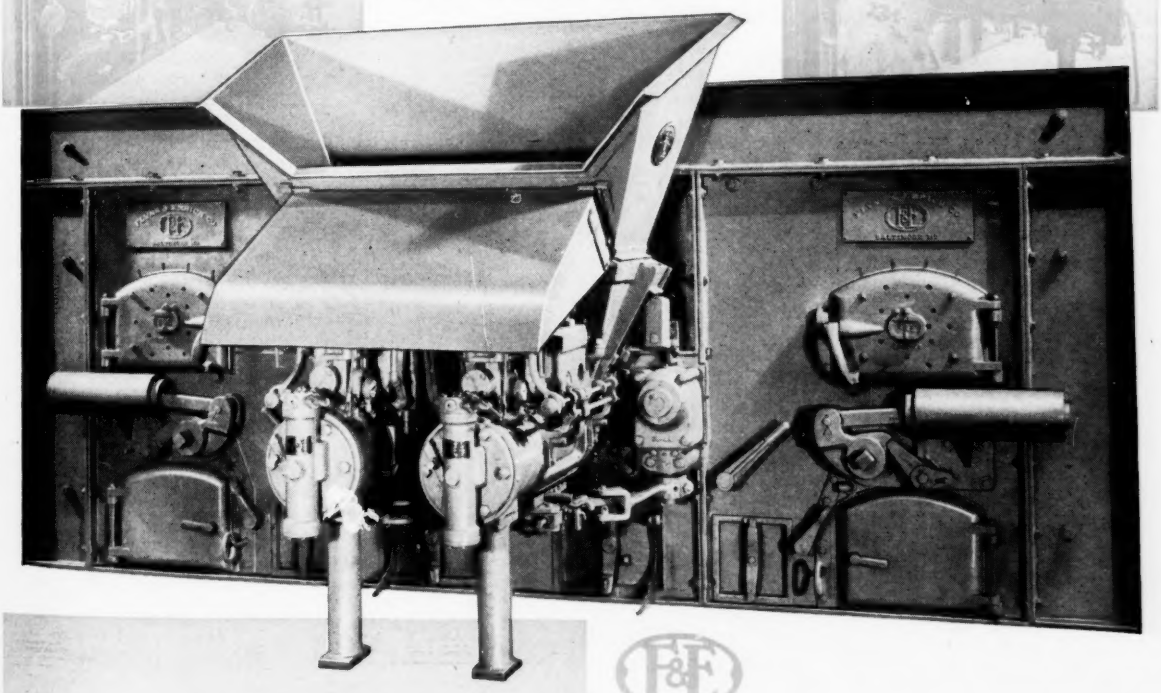

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Standardized Turbine-Generator Units

By J. R. CARLSON

Central Station Steam Engineer, Westinghouse Electric Corp., South Philadelphia, Pa.

Summary of preferred standards for units from 11,500 to 60,000 kw capacity suggested by joint AIEE-ASME committee . . . Extraction pressures can be grouped in narrow ranges . . . Variations in throttle flow with number of extraction stages, variable vacuum . . . Effect of throttle pressure reduction . . . How standardized machines utilize capability at various power factors . . . Influence of hydrogen cooling at different pressures on generator and turbine capability . . . Standardization promises lower costs, quicker shipment, greater reliability, better co-ordinated turbine-generator, trouble-free heat balances, optimum steam conditions

STANDARDIZED turbine-generator units offer many advantages to user and manufacturer alike. Lower cost, quicker shipment, optimum matching of steam pressure and temperature, and a co-ordinated turbine and generator can be realized from standard construction.

A little over a year ago, a joint committee of AIEE and ASME members submitted a report suggesting certain preferred standards. These standards do not prevent users from purchasing non-standard equipment. However, in the range of sizes from 10,000 to 60,000 kw, many economies can be realized in the purchase and use of the standardized machines.

Influence of Extraction Pressures

One of the problems faced in the standardization program was the variety of existing heat-balance arrangements. It soon became obvious, however, that it would be possible to group extraction pressures into narrow ranges. Data available showed that extraction pressures could be varied widely with practically no change in efficiency. The problem before the committee then was one of resolving extraction pressures into economic practical values, which would produce results acceptable to the majority. In accomplishing this, as shown in Table I, the ideas of dozens of users as well as the ideas of manufacturers were weighed and carefully analyzed. Temperature of the feedwater to the boiler had an effect on its design and was considered so as to result in not only an efficient heat-balance arrangement, but also an economic boiler and turbine.

However, it is not enough to specify what the extraction pressures should be as they vary with the steam flow. A change in the vacuum or a change in the number of heaters used will change the steam flow through the turbine for a given output. For example, the rated load steam flow applying to a 30,000-kw turbine with steam applied at 850 psig, 900 F and an absolute pressure of 1 in. and 2 in of mercury with two, three, four, and five stages of feedwater heating, is as shown in Table II.

If the stage pressures are proportioned for four stages of extraction at 1 in. of mercury absolute, the pressures will be about 5 per cent higher when operated at 2 in. absolute and five stages of feedwater heating. It should also be noted that the steam flow through the high pressure nozzles varies with the number of heaters used.

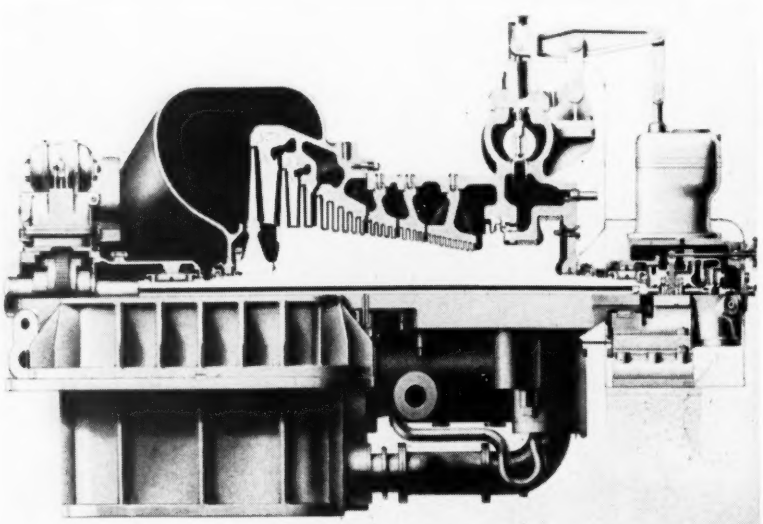


Fig. 1. Longitudinal section of 25,000-kw condensing turbine

Recommendations on Exhaust Pressure

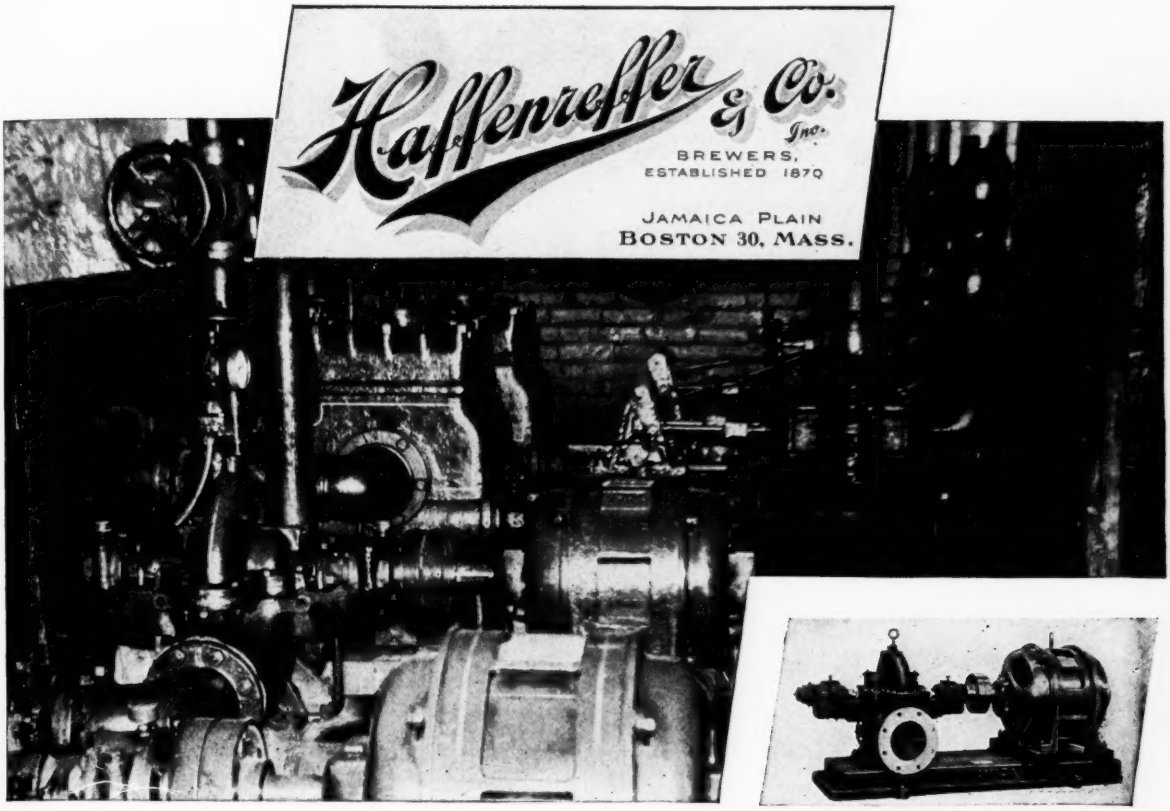
The Committee recommended that the design exhaust pressure for the turbine be 1.5 in. Hg abs. Such a design condition would result in a turbine of sufficient exhaust annulus to produce a good overall efficiency through the usual range of vacua. It was also specified that the nominal capability output of the turbine would also be obtained at 1.5 in. Hg abs. With such a limitation, turbine users in the South and Middle West were penalized, because their maximum load occurs during the hot

Table I. Extraction pressures at turbine casing at full load when operating with stage heating

Heater No.	Abs. Pressure	Saturation Temp.
1	6.72	175
2	22.8	235
3	53.2	285
4	134.6	350
*5	276.7	410

* 5th extraction point is not available in ratings of 11,500, 15,000 and 20,000.

Another famous user of WARREN PUMPS!

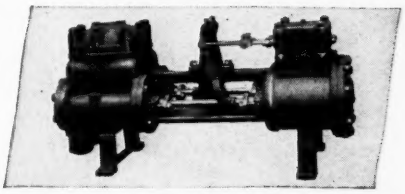


Haffenreffer and Co., brewers in Boston since 1870, depend on Warren Centrifugal and Reciprocating Pumps for efficient, low-cost, long-life pump performance, just as many breweries and widely varied industries have depended on Warren Pumps for the past half century.

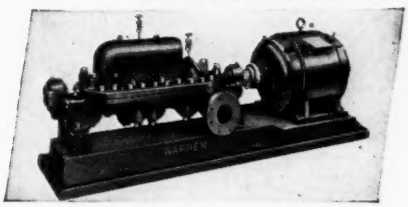
For 50 years Warren engineers have designed and built pumps that have solved the pumping problems of hundreds of plants. If you have a pump problem we invite you to write us, letting us have as much detailed information as possible. Our engineers will be glad to make recommendations, with no obligation on your part.

Warren Steam Pump Company, Inc.
WARREN, MASSACHUSETTS P-8

Warren DM and DL, Single Stage, double-suction centrifugal pumps are widely used on various general services. Special metals, capacities, heads, etc., are available to meet various operating conditions.



"Realwear" Horizontal Duplex Piston Pumps—a favorite for boiler feed, fuel oil pressure, oil transfer, general water services, etc. Type TM (below) Four and Six Stage for high pressure requirements in boiler feed, etc.
Write for special bulletins



WARREN PUMPS

Table II. Variations in turbine throttle flow with varying number of stages of feedwater heating and variable vacuum

Stages of Feedwater Heating	Pounds of Steam Per Hour			
	1.00" Hg.		2.0" Hg.	
	Steam to Turbine	Steam to Condenser	Steam to Turbine	Steam to Condenser
2	254 500	197 700	263 400	205 000
3	255 900	194 700	265 500	202 000
4	257 700	192 000	267 700	199 400
5	259 700	190 100	269 900	197 600

summer months when the vacuum is the poorest.

This difficulty was circumvented by nozzling the turbine so it would develop 100 per cent of rating with five stages of feed water heating and with 2.5 in. absolute back pressure. Expressed in another manner, the exhaust end was proportioned to give good efficiency with absolute back pressure of 1.5 in. but, by increasing the nozzle capacity a small amount, the standard turbine would develop its guaranteed capability even with poor vacuum conditions. This small increase in size of the high-pressure nozzles made the standardized turbines highly acceptable. Those users who operate with a reduced number of heaters or with higher vacua merely obtained increased turbine capacity and, incidentally, unit output which has the full approval of the manufacturer.

unit as a whole is more closely matched between turbine and generator. "Conventional" turbines are nozzled to develop 125 per cent of rated load or the kva capacity of the generator (80 per cent p-f generator) at unity power factor. The only way the full turbine capacity can be utilized with an air-cooled generator is to raise the power factor to unity. With a hydrogen cooled generator, the situation is not so unbalanced, for 15 per cent greater generator capacity can be obtained with 15-lb gas pressure as compared with one-half lb normal gas pressure. This will permit developing the maximum turbine capability with a power factor of 87 per cent.

In the past, generators were normally designed for a power factor rating of 80 per cent. Today it is evident that the average operating power factor is nearer 90 per cent. A saving in generator costs

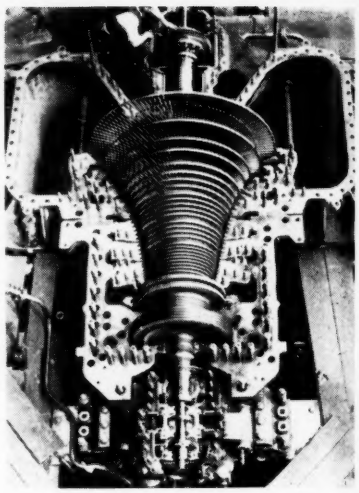


Fig. 2. Typical construction of standardized turbines in sizes of 11,500, 15,000, 20,000 and 30,000 kw

can be obtained by designing it for a power factor of 85 per cent instead of 80 per cent. Standardized turbines have a maximum capacity of 10 per cent in excess of rating. When matched with the new 85-per cent-power-factor generators, air cooled or hydrogen cooled at one-half lb gas pressure, their maximum capability can be obtained with a power factor of 93.5 per cent instead of 100 per cent with the conventional machines. At 15 lb gas pressure, on hydrogen-cooled generators the power factor need be only 83 per cent as compared with 87 per cent. (All generators are hydrogen cooled except the two smallest ratings).

Table III. Change in maximum turbine capability with variations in exhaust pressures

Initial Steam Pressure Lb. Ga.	Initial Steam Temp. Degrees F.	PER CENT CHANGE IN KW CAPABILITY EXHAUST PRESSURE - IN. HG. ABS.					
		1.0	1.5	2.0	2.5	3.0	3.5
600	825	+3.9	+3.1	+1.8	0	—1.9	—4.0
850	900	+3.3	+2.6	+1.4	0	—1.7	—3.5
1250	950	+2.6	+2.0	+1.2	0	—1.5	—3.0

The effects of variations in exhaust pressure on turbine capacity for the six standardized sizes are shown in Table III.

The reduction of turbine capacity with reduced operating pressure of 50 pounds will be as shown in Table IV.

For a 50-degree reduction in operating temperature, the kilowatt capability of the turbine will be reduced by 2 per cent.

When operated with designed conditions, the turbine capability will be increased by 4 per cent when no steam is extracted from the highest extraction outlet.

Matching Turbine and Generator

The standardized turbine-generator

Table IV. Variation in turbine capability with a 50-lb reduction in throttle pressure

Initial Steam Pressure Lb. Ga.	Initial Steam Temp. Degrees F.	PER CENT REDUCTION IN KW CAPABILITY
600	825	9
850	900	6
1250	925	4

Generator Details

A number of years ago, very little thought was given to generator short-

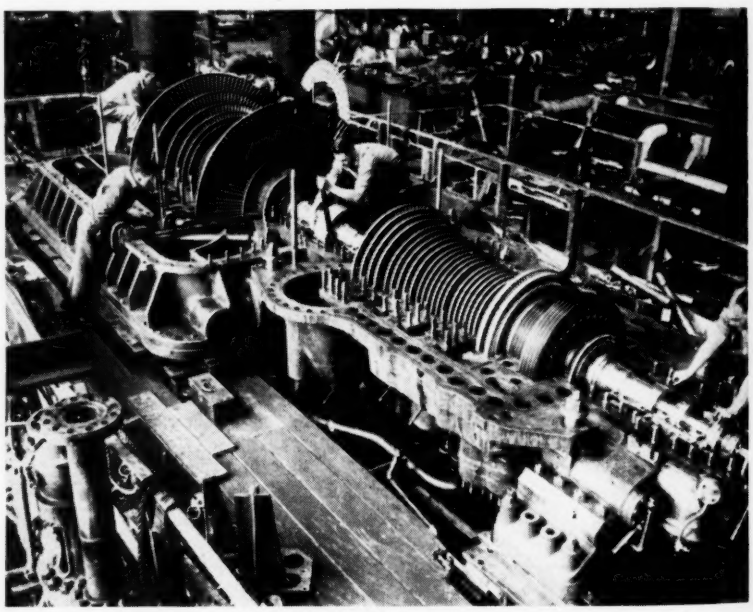


Fig. 3. Typical construction of standardized turbines in sizes of 40,000 and 60,000 kw

UNION "L" TYPE BOILER

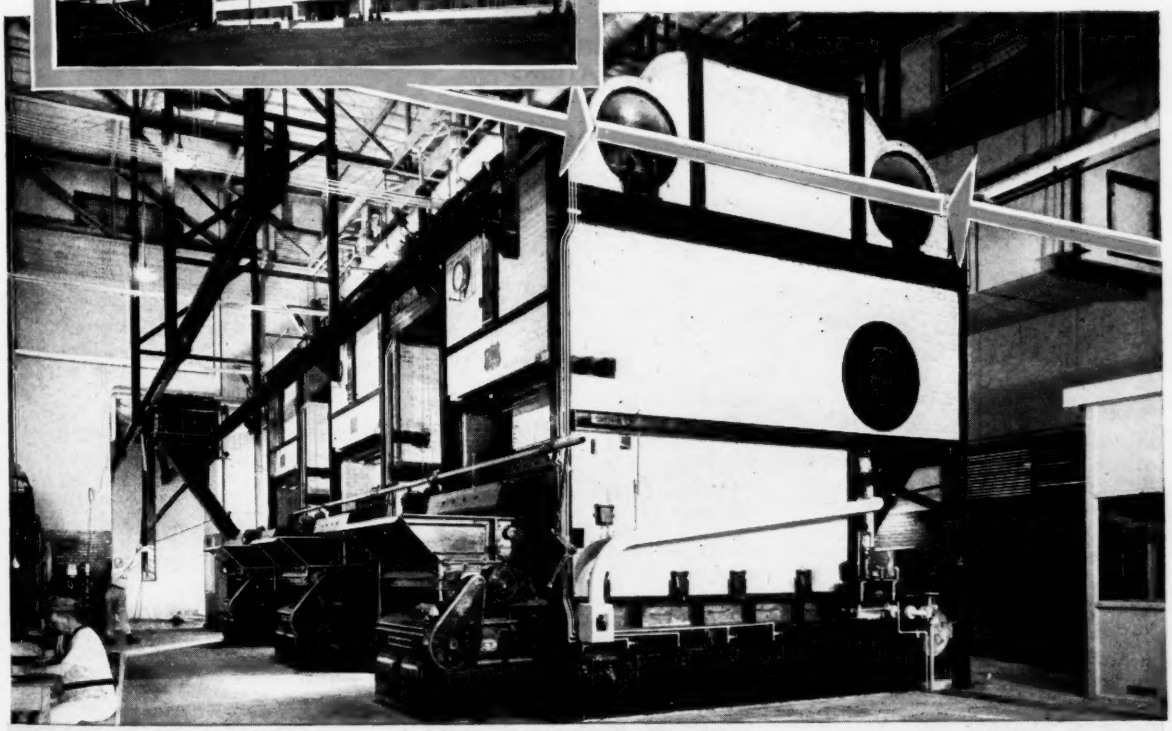
Features 2 TOP DRUMS ON SAME LEVEL

TYPE "L", the low headroom 3-drum boiler, one of the 13 basic types of Union Boilers features large steam releasing surface. The two top drums located on the same center line without complete submergence of either drum are equally steam and water drums.

This principle of drum placement permits a compact design with an unusually steep front tube bank. The slope of the front tube bank is 3" per foot. The combination of these features assures rapid circulation as well as a large steam disengaging surface.

The Union "L" Boiler is adaptable to stoker, pulverized coal, and oil firing. Write for Bulletin "L" for complete data on this low headroom boiler.

3 UNION Type "L" Low Headroom. 3-drum boilers installed in the modern plant of The Emerson Electric Manufacturing Co., at St. Louis, Mo. Plant was designed and built by The Austin Company, Cleveland, Ohio.



UNION IRON WORKS - - - *Since 1890*

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BOILERS — PROCESS EQUIPMENT — FABRICATED STEEL

Table V. Preferred standard for large 3600-rpm, 3-phase, 60-cycle condensing steam turbine generators

1. Turbine Generator rating-kw	11,500	15,000	20,000	30,000	40,000	60,000	
2. Turbine capability-kw	12,650	16,500	22,000	33,000	44,000	66,000	
3. Generator rating-kva	13,529	17,647	23,529	35,294	47,058	70,588	
Power factor	0.85	0.85	0.85	0.85	0.85	0.85	
Short circuit ratio	0.8	0.8	0.8	0.8	0.8	0.8	
4. Throttle pressure-psig	600	600	850	850	850	1250	850 1250
5. Throttle temperature-F	825	825	900	900	900 or 950		900 or 950
6. Number of extraction openings	4	4	4	5	5	5	
7. Saturation temperatures at 1st	175	175	175	175	175	175	
8. Extraction Opening at 2nd	235	235	235	235	235	235	
9. Turbine-Generator Rating 3rd	285	285	285	285	285	285	
10. With all Extraction Open- 4th	350	350	350	350	350	350	
11. ings in Service-Degrees-F 5th	–	–	–	410	410	410	
12. Exhaust pressure-in Hg. Abs.	1.5	1.5	1.5	1.5	1.5	1.5	

	Hydrogen-Cooled Generator Operated at 15 Psig Hydrogen Press			
13. Generator capability at 0.85 power factor—kva	27,058	40,588	54,117	81,176

Notes (1) A tolerance of plus or minus 10 F shall apply to above saturation temperatures. (Tolerances shall be unilateral so as not to reduce the spread in temperature between adjacent extraction openings.)

(2) "Turbine capability" is guaranteed continuous output at generator terminals when the turbine is clean and operating under specified throttle steam pressure and temperature and exhaust pressure, with full extraction from all extraction openings.

14. Standard generator voltages (all sizes)	11,500	12,500	13,800	14,400

circuit ratio. As system capacities increased, a general feeling developed that short circuit ratios should be high to permit stable operation. The work of the standardization committee showed that generator short circuit ratios in Europe and this country varied from 0.6 to 1.2. Their investigation also showed that, unless there were extenuating circumstances, short circuit ratios of 0.8 were entirely ample, thus again resulting in a saving in the amount of iron and copper built into the generator.

All hydrogen-cooled generators have a heavy steel gas-tight housing or shell enclosing the generator proper. Enclosed in this housing are the hydrogen gas coolers. These gas coolers can be designed for any cooling water temperature from 70 to 95 F. The size of the 95-degrees gas cooler is several times as large as for the lower temperatures. To reduce the number of gas-tight housings for conventional generators, the manufacturers developed two; one which would accommodate gas coolers for water temperatures through 85 F, and a second one large enough to accommodate gas coolers designed for 95 F. The Committee concluded that the need for 95-degrees cooling water was rather remote and one housing capable of accommodating gas coolers designed for 90 F cooling water was sufficient.

Advantages of Standardized Units

Standardization has very definite advantages to the user, and these are as follows:

(1) Lower costs, which should result in cheaper power plants. For example, a standardized 30,000-kw turbine generator unit costs approximately the same as the conventional 25,000 kw.

(2) Quicker shipment. The engineering work will all be completed on the standardized units and the work can be entered in the shop with a minimum of delay. In fact, if the activity is great enough, parts or complete turbines can be stocked.

(3) Greater reliability. Repetitive manufacture permits manufacturing difficulties to be eliminated. Continued operation of duplicate units would soon disclose any inherent design weakness, which can be readily corrected and avoided in later machines.

(4) Standardization of extraction openings. The location of extraction zones in the turbine are in accordance with the best engineering knowledge of the country. Heat balances worked up from these standards should almost automatically be free of trouble.

(5) Turbine and generator co-ordinated. The maximum turbine capability and generator kva capacity are so coordinated as to permit the maximum utilization of both in the production of kilowatt output.

(6) Steam pressures and temperatures which no longer should be considered independent variables are carefully matched. For each pressure, an operating temperature is selected which results in good low pressure blade life. Furthermore, except for the two largest ratings 40,000 and 60,000 kw, only one definite but economic operating steam condition is used for each rating. For the two largest ratings, a choice of two economic operating conditions is provided.

ASTM DISCUSSES PAINT, NEW SPECIFICATIONS FOR METALS, OILS

DURING Committee Week of the American Society for Testing Materials, held in Philadelphia February 24 to 28, inclusive, a Symposium on Paint with a number of technical papers featured the Spring Meeting of the Society. Methods of Evaluation of Paints will be discussed, the finishes to be covered including those used in industrial, automotive, container and marine applications; also Evaluation of Paint Materials and Statistical Analysis of Paint Test Data.

Acting through the Administrative Committee on Standards, the Society has recently approved quite a number of new and revised specifications and test methods. All of the new and revised tentatives will be included in the 1946 Book of A.S.T.M. Standards now being printed, and the specifications and tests will be available in separate pamphlet form either before the big books are issued or immediately thereafter. The new Tentative Specification covering Fire-Refined Copper for Wrought Alloys (B 216) essentially replaces the Emergency Specification ES-7 developed as a wartime measure and widely used to cover a large variety of applications. A new Tentative Specification for Soft Solder Metal (B 32) replaces the former specification carrying the designation B 32-40 T, and a significant new Tentative for White Metal-Bearing Alloys (known commercially as Babbitt metal) also will replace the current standard B 23, which has not been revised in twenty years. New specifications for corrosion-resistant chromium and chromium-nickel steel electrodes A 298-46 T have been in course of promulgation since 1940, when the subcommittee was first organized. The test requirements set up minimum quality levels which will assure suitability for the usual applications.

The two new methods covering Determination of Sulfur in Lubricating Oils which Contain Additives (D 894) and the Test for Normal Pentane and Benzene Insolubles in Used Lubricating Oils (D 893) have been under consideration for some time in Committee D-2. The new Sulfur Method (D 894) is intended for both new and used lubricating oils which have additives. The sample is oxidized by combustion in a bomb containing oxygen, under pressure. The sulfur, as sulfate in the bomb washings, is determined gravimetrically as barium sulfate. The new method D 893 not only outlines the procedures to be used, but incorporates certain significant definitions, for example, a "used lubricating oil" is defined as "the oil and suspended contaminating matter which circulates through a lubricating oil system during operation and which can be drawn from the oil system during or immediately following a period of operation; it does not include deposits in the system or large contaminating particles which may have separated from the oil in the system." Revision in the methods of sampling and testing untreated paper (D 202) involves the addition of a method of testing pH of paper.

ARE THESE MONEY LOSSES GOING ON *Behind your Back?*

STOP THEM WITH THE CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVE

If costs keep coming at you from such sources as pictured above due to certain valves on your line . . . STOP THEM! Put the entire matter in the "hands" of the CASH STANDARD Streamlined Type 1000 Pressure Reducing Valve . . . then you can keep your back turned to the CASH STANDARD "1000" Valves for years, because there will only be benefits coming at you as shown on this page. SUGGESTION . . . write for Bulletin 962.

BENEFITS..

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CASH STANDARD CONTROLS . . . VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

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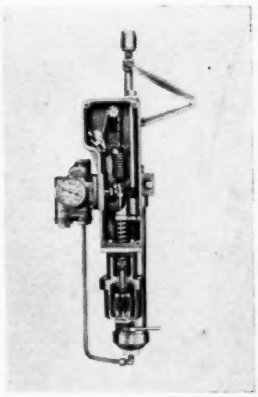
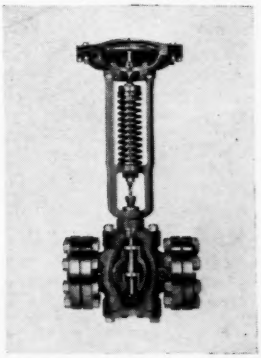
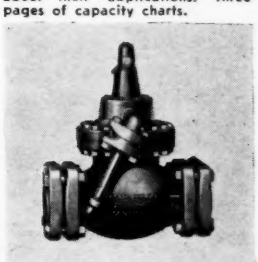


Bulletin 963 features the CASH STANDARD Type 100 Series of Super-Sensitive Controllers — various types for automatically operating valves, dampers, rheostats, stokers, pulverizers, fans, and other apparatus. 16 pages filled with descriptions and applications.



Bulletin 968 features the CASH STANDARD Type 34 Pressure Reducing Valve — direct operated — direct acting for handling steam, hot water, cold water, air, oil, brine—and most liquids and gases except some injurious chemicals. Illustrates and describes the different styles available and tells about their applications. Three pages of capacity charts.



Bulletin 956 features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.

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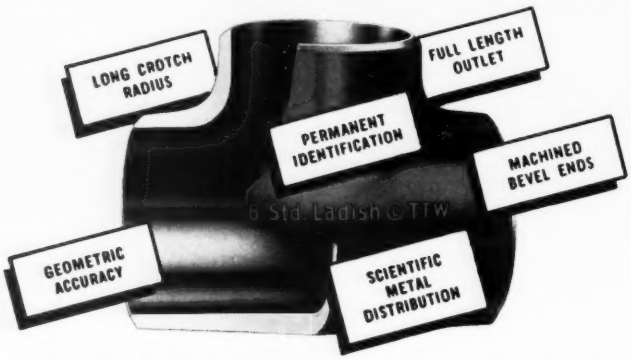

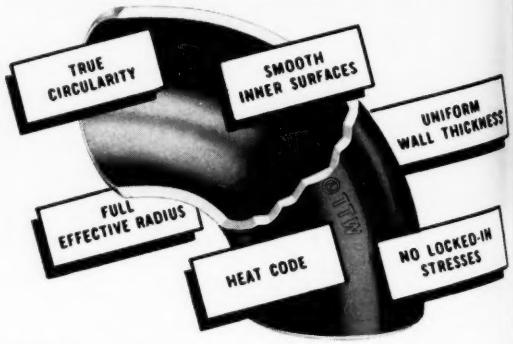

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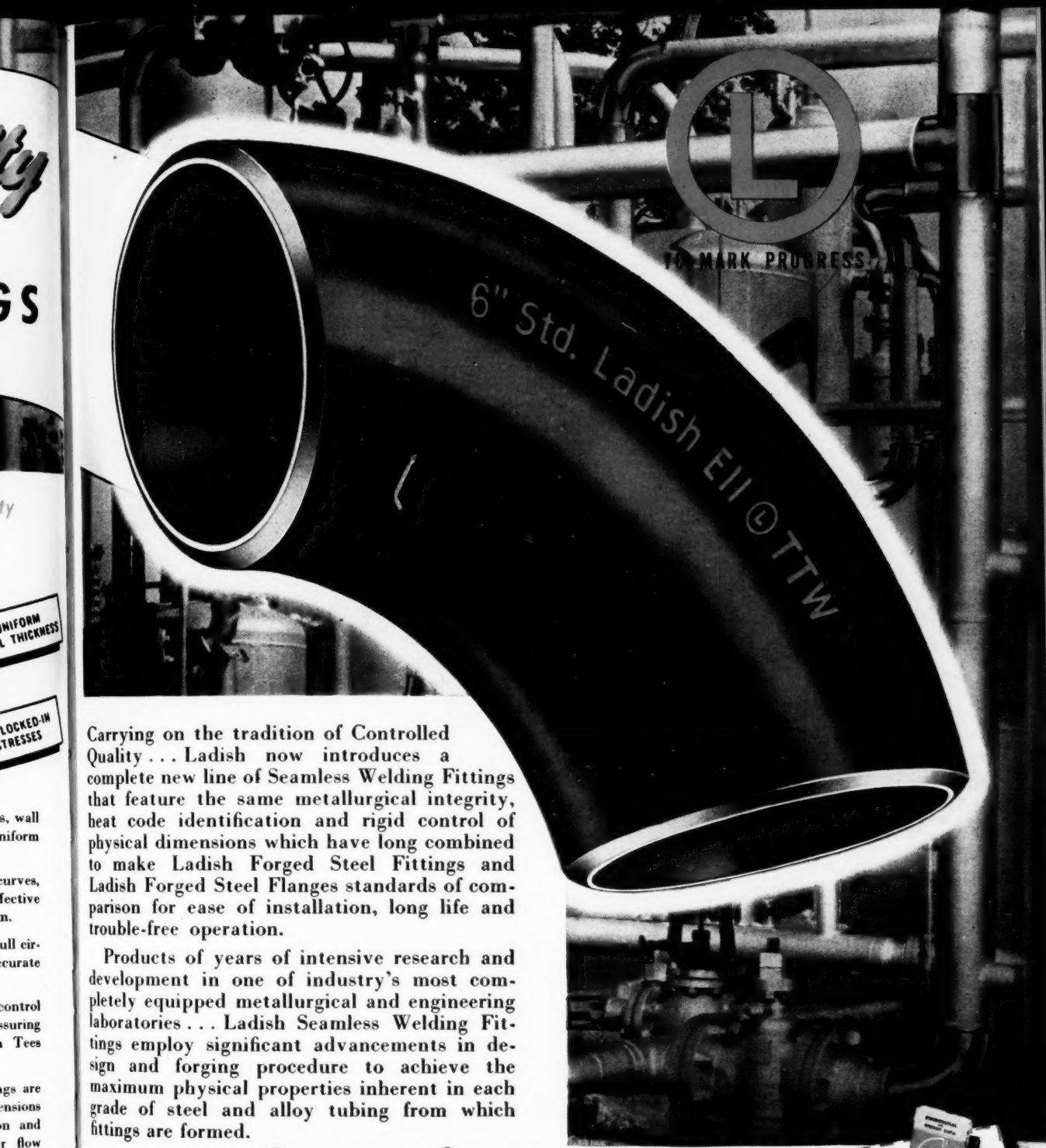

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Products of years of intensive research and development in one of industry's most completely equipped metallurgical and engineering laboratories . . . Ladish Seamless Welding Fittings employ significant advancements in design and forging procedure to achieve the maximum physical properties inherent in each grade of steel and alloy tubing from which fittings are formed.

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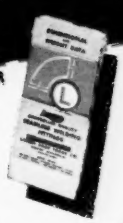

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Easy business and plenty of it is not conducive to good salesmanship nor to straight thinking, any more than a big meal improves the appetite and sharpens the wit.

A dozen or two fat orders via the transom and some short sighted companies put the brakes on selling and advertising efforts . . . stalling the "engine" which then gets temperamental when it is needed.

"Why advertise?" they ask. "We'll never fill the orders we've got."

And they're right! . . . about not filling the orders, we mean.

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Would you like to see a couple of case histories of what happened to companies that discontinued advertising because they were "oversold"? Would you like to have copies of this ad to send to others in your organization? Just drop a note to A.B.P. headquarters and we will send them to you.

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Established 1870
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TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

TODAY'S MEN AND YESTERDAY'S MACHINES

(Continued from page 67)

steady jobs and a satisfactory margin between wages and prices.

That's one reason why I do not like some of the terminology employed in selling machine tools. A machine tool salesman makes a study of an operation and recommends, let us say, three new machines to take the place of ten old ones. He says to management, "If you buy the new machines, you can eliminate seven operators, thereby saving such-and-such number of dollars on direct labor."

Now if we are going to employ that kind of terminology, is it any wonder that the men in the plant may get the impression that the installation of new machines means that men are going to be fired? Is it any wonder that men limit their output per hour, under the mistaken impression that by so doing there will be more jobs to go round?

Here are three facts I want you to consider carefully in relationship to each other:

1. The average write-off period for machine tools is 20.74 years.
2. The average period for obsolescence of machine tool models is about seven years.
3. In normal times it is virtually impossible to sell a new machine tool unless you can prove to the customer that it will pay for itself in less than three years.

Now, when you try to put those three facts together, they don't make sense.

If a machine tool pays for itself in three years and becomes obsolete at the end of seven, why should it be depreciated on a 20-year basis?

This paradox leads to complications that would be amusing if they weren't so serious.

A company is considering, let us say, buying $100,000 worth of new machine tools. The controller points out that the old machine tools, to be replaced, originally cost $80,000; that they are seven years old; that they have been depreciated at 5 per cent and therefore remain on the company's books at a valuation of $52,000. The company finds that in the secondhand market it could get only $20,000 for the old machines—$32,000 less than the book value. Therefore, the controller insists that the new machines will cost not only the $100,000 paid for the new machines, but in addition $32,000 of loss on the old machines, or a total of $132,000.

This sort of reasoning causes unsound resistance to the purchase and installation of new equipment.

The machines to be replaced had no doubt paid for themselves in the first three years—otherwise the company would not have bought them. At the end of seven years those machines didn't owe the company a thing. They had accomplished their purpose. They had saved that company plenty of money. Then they had become obsolete, high-

From the moment the Dearborn Engineer steps in your door, he is in your service.

He starts by making a thorough study of your boiler operating conditions.

He sends water samples to the Dearborn laboratories where accurate chemical analyses are made. Laboratory experts recommend the proper treatment and control methods for your complete protection.

. . . He makes sure that name means what it says

DEARBORN SERVICE TAKES TROUBLE OFF YOUR HANDS

If chemical feeding equipment is necessary, suitable means are recommended, making use of the versatile line of Dearborn mechanical equipment. He instructs your operators how to use the testing apparatus in connection with treatment adjustment and blowdown control. Thereafter, he makes periodic checks to insure maintenance of recommended boiler water conditions.

This service, indeed, means that your plant is set to deliver power!

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WATER TREATMENT AND ENGINEERING SERVICE

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Service over the years with FORGED STEEL UNIONS

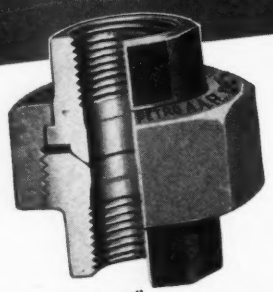
Unions are hot forged from solid round bars of high quality Open Hearth Forging Steel.

Handle-Bar

Hi-Speed Handle-Bar Unions with integral steel to steel seats, or completely fused bronze to bronze seats, black or Udylite (cadmium plated) — sizes from ⅜" to 4" inclusive in 4000 test, sizes 2" to 4" inclusive in 6000 test.

4000 Test Unions furnished with Briggs Standard steam threads in pipe ends, whereas the 6000 Test Union has long pipe ends with API line pipe threads. Nut threads are modified Acme to facilitate easy and speedy assembly and disassembly. Seat design is a 45 degree cone, machined and cold rolled, to a ball seat on male end. Handle-Bar Unions are recommended for all services where they are made up and taken down frequently.

Petro



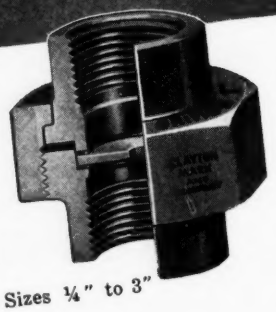
Sizes ⅛" to 3"

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S. W. P.-2000 lbs. C. W. P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is used.

Orifice

Ideal for flow control of Steam, Oil, Ammonia, Water, Gas or Air. Also for metering and measuring. 600 lbs. S. W. P. or 2000 lbs. C. W. P. The ORIFICE plate is furnished in cold rolled 18-8 stainless steel. ORIFICE plate and gaskets are set in a groove of solid steel to safeguard against blowing of gaskets and resultant trouble. The ORIFICE union has extra heavy ends and nut with the nut threads permanently lubricated.



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cost items. Replacement was imperative in order to get more output per man per hour. And yet, here was a controller still persisting that the elimination of those old machines would *cost* the company $32,000 on top of the purchase price of the new machines.

The problem there was not whether or not the old machines should be replaced. Of course they should be replaced. The trouble was in the depreciation policies of the company. Equipment that may become obsolete in seven years should not be set up on a 20-year depreciation schedule.

While there has been consistent Treasury Department resistance against the idea of setting up depreciation schedules based upon the estimated profitable life of the machine, nevertheless, companies that have carefully set up individual schedules on each important item of production equipment have succeeded in getting Treasury Department permission to shorten substantially the length of the depreciation period.

To my mind, it is incumbent upon both machine-tool-using, and machine-tool-building, companies to wage an aggressive campaign on behalf of more intelligent depreciation practices upon the part of companies, and a more tolerant and understanding viewpoint in this connection upon the part of the U. S. Treasury Department.

The *builder* of such equipment lives in a perpetual risk of a somewhat different nature.

In order to survive, he is constantly betting against the future. He is betting that, through invention, design and research, he can improve the performance of his product at a rate which will assure him a continuing volume of business.

I want you to think that over for a moment. It is up to us, as machine tool builders, for instance, to provide manufacturers with the means whereby they can continue always to make better things for more people at less cost. I keep coming back to that phrase because it is the key to the whole picture.

In other words, unless the builders of productive equipment can enable the manufacturers of this country steadily to increase the general standard of living, the builders of productive equipment will have to go out of business.

In conclusion—I might say that there is one factor in connection with which there is no risk. There is one factor upon which you can always depend, regardless of war, government, labor, or anything else. *That factor is obsolescence.* Like death and taxes, it is always with us.

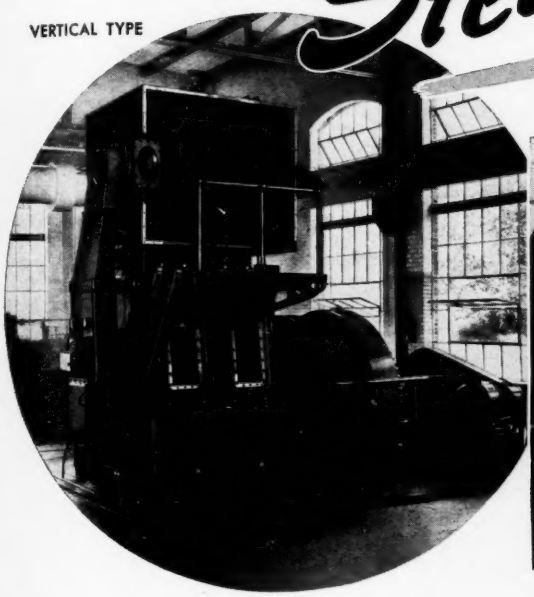
SESA TO HOLD MAY MEETING

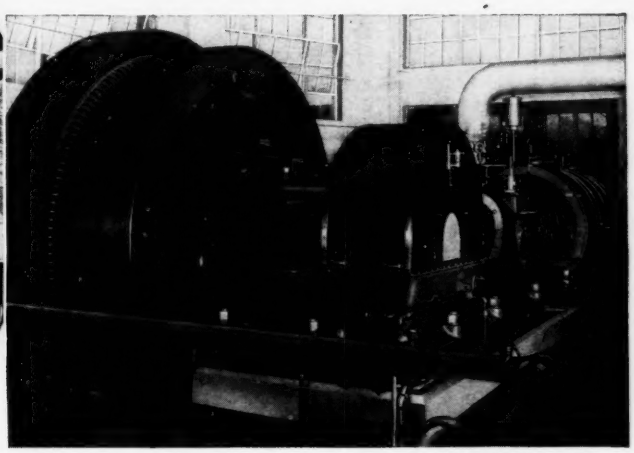
THE ANNUAL Meeting of the Society for Experimental Stress Analysis including A Symposium on Shock and Impact, will be held at The Stevens Hotel, Chicago, Ill. on May 15, 16, 17, 1947.

Inquiries should be addressed to the Society for Experimental Stress Analysis, P.O. Box 168, Cambridge 39, Mass.

Skinner "UNIVERSAL UNAFLOW" Steam Engines

VERTICAL TYPE





HORIZONTAL TYPE

• WHAT THEY ARE

The Skinner "Universal Unaflow" Steam Engine is the outstanding reciprocating prime mover of this era, made by the largest exclusive manufacturer of steam engines in America. The performance of thousands of "Universal Unaflow" engines, in almost every type of industry and institution, daily demonstrates the truth of our claim—that they are "the most economical steam engines built."

"Universal Unaflow" engines are correctly designed for simplicity, dependability, heavy duty service, flexibility, and permanently maintained economy. They are available in sizes ranging from 75 to 2,250 horsepower, and in horizontal or multi-cylinder vertical types.

• WHAT THEY DO

Skinner "Universal Unaflow" Steam Engines are built for direct connection, coupling, or belt drive, to electric generators, compressors, blowers, pumps, lineshafts, or other load.

Over 2000 power users, in industries and institutions, have found it more economical to generate their own power with "Universal Unaflow" engines than to purchase power from the local utility, or to generate power with other prime movers.

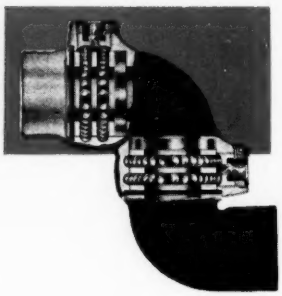
Exhaust steam is available to be utilized for heating, for laundry, for processing techniques, and many other purposes, further adding to the savings enjoyed through use of "Universal Unaflow" engines.

Skinner "Universal Unaflow" engines are frequently bought under our Guaranteed Saving Contract, payments being made out of proved savings after the engine is in service. Write for detailed information of the advantages of Skinner "Universal Unaflow" engines in your industry.

For Over 75 Years, Doing One Thing Well—Building Steam Engines

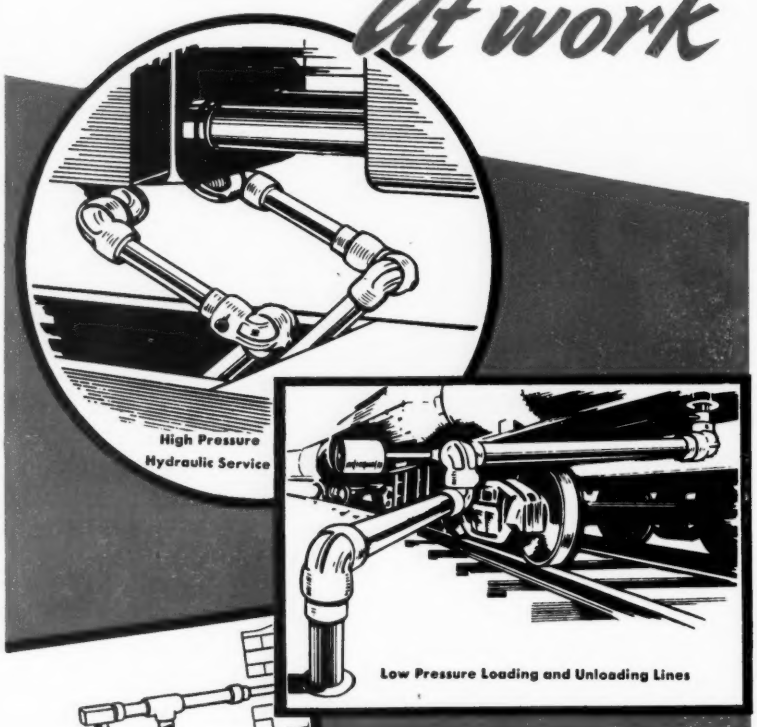
SKINNER ENGINE COMPANY, ERIE, PA.

CHIKSAN



BALL BEARING SWIVEL JOINTS

At work



Look around you and you will see CHIKSAN *Ball-Bearing* Swivel Joints at work in many different applications ...from low pressure loading and unloading lines to high pressure hydraulic equipment and under high temperatures on boilers and open hearth furnaces. CHIKSAN Swivel Joints are made in over 500 different Types, Styles and Sizes...for pressures from 300 psi to 12,000 psi and temperatures to 500° F...for full 360° rotation in 1, 2 and 3 planes...with threaded or flanged ends or bored for welding. Write for CHIKSAN CATALOG No. 45.

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CHIKSAN COMPANY
BREA, CALIFORNIA
New York 7 Houston 2

DUCT CHANGE TRIPLES FAN LIFE

(Continued from page 80)

leaves the economizer vertically downward at K. It then changes direction to a flow intended to be parallel with the fan shaft and in an "outboard" direction, L. In so doing, a contraction occurs, due to the presence of economizer support, M. The stream then immediately turns 90 deg, NP, toward the inlet box.

Proper calculations determine the number and details of sheets shown at KL and NP of Fig. 5.

At the same time (Fig. 4) the gas flow on the power side of the setup makes only one change of direction, i.e. from vertically downward at Q leaving the economizer horizontally at R, toward the power side inlet box. Proper vaning, QR, is shown in Fig. 5.

From the inlet box entrances to the stack, the flow is the same at outboard and power sides of the fan. Details of the ductwork and nature of the flow "as installed" are shown in Fig. 4 elevation. The change of direction of approximately 110 deg, just downstream from the inlet box entrances, causes a strong unintentional spin within the inlet boxes. Such a spin seriously impairs the capacity and efficiency of the fan as well as exaggerating wheel erosion.

Means used for correcting these disadvantageous conditions are shown in Fig. 4, front elevation, at RS.

All Changes in Ducts, None in Fan

Thus, the "as installed" system was modified by internal streamlining of the flow *within the ductwork. The physical shape of the fan and its inlet boxes remained as originally shipped by the fan manufacturer.* In this particular case, the customer merely welcomed such suggestions as the fan manufacturer offered; he did not blame the problems on the fan. The much more usual procedure is to blame the mechanical draft fans for (1) deficiency of steam generating capacity (although fans, of themselves, cannot generate steam), (2) abnormal driving motor loads (although temperature of gas or air through fans, actual fan speed, abnormal flow to and from the fans, etc. are factors controlling the brake horse power), (3) excessive erosion (although the nature of the ductwork connected to the fan contributes largely to erosion intensity), (4) noise (although the identical fan can be used on two systems where the noise is objectionable on one system), etc.

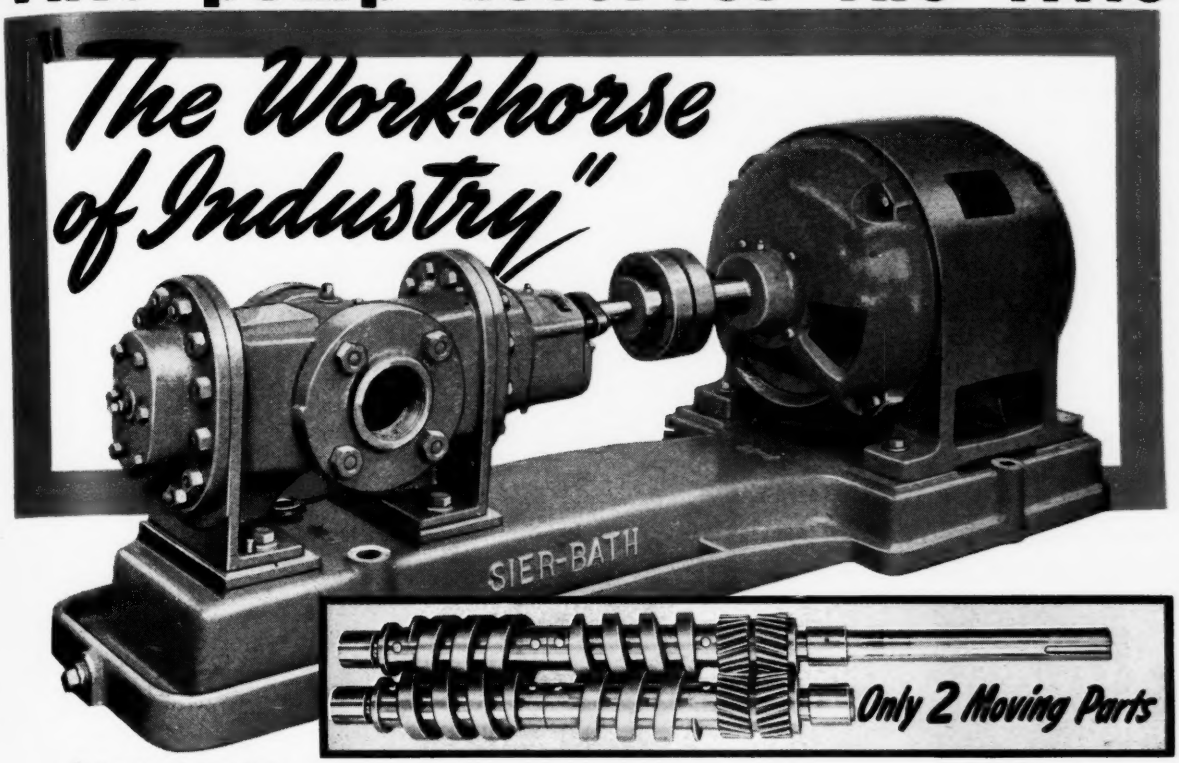
Now, without further digression, consider what results were accomplished by merely installing guide sheets—often ridiculed as being too theoretical for consideration.

Results Obtained

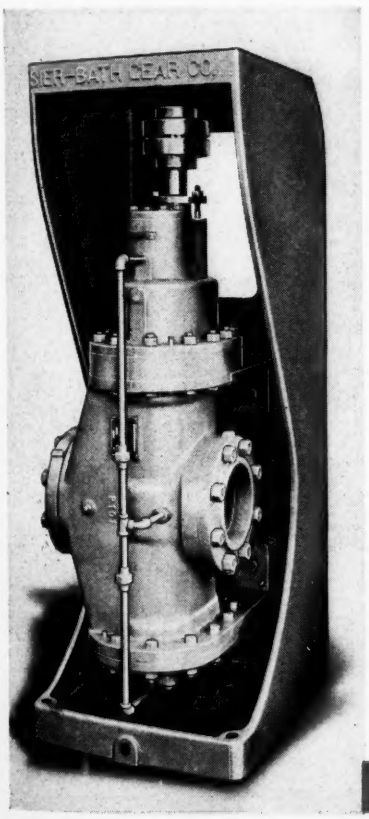
The original purposes were: (1) to satisfy the need for 10 per cent increase in steam capacity and (2) decrease the excessive flyash erosion of the induced-draft fan wheel.

More specifically, the maximum output was 210,000 lb steam per hour "as

This pump deserves the title



● Sier-Bath Screw Pumps, Horizontal Model, Internal Gear Type.



●Vertical Model. This unit handles Bunker C Fuel Oil. Rated at 350 g.p.m. 50 p.s.i., 10" vacuum 20 H.P. 1150 r.p.m. motor drive. Built for Y tankers A.S.F.

IN DESIGN, materials and construction, nothing has been overlooked to make Sier-Bath Screw Pumps the most efficient units of their type. Made in an up-to-date precision gear shop, equipped with the most modern machinery, these pumps always perform up to the high standards required by users. They are used for pumping the most viscous of liquids—acetates, asphalts, brines, Bunker C fuel oil, cellulosics, greases, molasses, syrups, etc.

Sier-Bath Screw Pumps are made both in horizontal and vertical models. They are less affected by head than other displacement pumps. Angle of inclination at which they operate is unimportant. They run without vibration or pulsation. Needle bearings are standard equipment. Send for descriptive booklet.

FOUNDED 1905 MEMBER A.G.M.A.

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GEAR and PUMP CO., Inc.

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See Your Supply House or Send for Bulletin S-201

YARNALL-WARING COMPANY
114 Mermaid Avenue PHILADELPHIA 18, PA.

YARWAY STRAINERS

installed"; 230,000 lb per hr is the desired normal load rating.

The original wheel was cut in two in 32 months; any possible extension of wheel life would be welcomed.

In tabular form, the actual gains are summarized as shown in the accompanying table:

In addition, it should be noted that if the 210,000 lb per hr was increased to 260,000 at constant fan efficiency (such as by fan speed increase), the 210 amp input would have increased as the cube or to 397 amp. As actually accomplished by vaning the gas flow, 260,000 lb steam per hr requires only 204 amp. Or, roughly, the gas handling *efficiency* has been *about doubled.*

During the 85 months wheel life, to date, the only wheel maintenance required was the application of narrow wearing strips on the wheel blades in planes adjacent to the wheel centerplate after 31 months of service and building up of these wearing strips with welding rod after an additional 48 months of service.

The original driving motor and its foundation still remain. No new larger motor was needed. From the above tabulation note that the amperes input at 260,000 lb per hr load (which is an increase of 24 per cent over the original) is now less than it was for the original 210,000 lb per hr.

If a new plant or plant extension had to be built to gain this 24 per cent steam increase, the cost would make the cost of the simply-fabricated, stationary guide sheets negligible by comparison. Even at $1 per pound of extra steam produced, the saving is very substantial. If the cost of a new building, etc. is included, the comparison is astounding.

There will be of course, a substantial saving in cost of power for fan operation during the entire future operation of the fan.

A plant extension, if made during these present trying times, would require months or years; the stationary guide sheets require only a matter of weeks—possibly days.

ASME HONORS PPE EDITOR

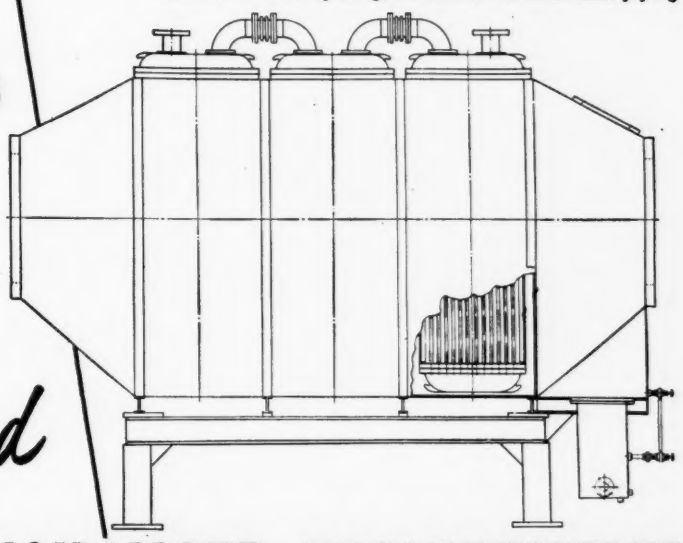
RALPH E. TURNER, editor, POWER PLANT ENGINEERING, was one of twelve past chairmen, Chicago Section, American Society of Mechanical Engineers who were honored by the presentation of a scroll for meritorious service for the Society. Past-president Alex Bailey, Vice President, Commonwealth Edison Co., Chicago, presented the scrolls at a dinner meeting held in the Adventurers Club, Thursday evening, January 23.

Those receiving the scrolls were: L. D. Gayton, 1933-1934; R. D. Brizzolara, 1934-1935; Prof. J. S. Kozacka, 1935-1936; Thomas S. McEwan, 1936-1937 and 1937-1938; R. E. Turner, 1938-1939; L. M. Ellison, 1939-1940 and 1940-1941; C. C. Austin, 1941-1942; John Michel, 1942-1943; John P. Magos, 1943-1944; F. H. Lane, 1944-1945; and J. C. Marshall, 1945-1946.

A past-chairman of the Rock River Valley Section, Walter C. Fischer, also received the award but was unable to attend the dinner.

Wm. S. Monroe, retired consulting engineer, was awarded his 50 year pin. Mr. Monroe first joined the ASME in 1896, was made a full member in 1901 and a Fellow of the Society in 1941.

Here's another example of Lummus' ability to meet . . . *Specialized* HEAT EXCHANGER REQUIREMENTS



Arrangement of one of four Lummus-designed exhaust-gas aftercoolers. Each has a series of three bundles in a single rectangular shell, providing a total of 12,300 effective square feet of tube surface. Bundles are in vertical position for easy removal by overhead crane to facilitate cleaning, inspection, and maintenance. Each unit is approximately 20 feet long by 16 feet high by 11 feet wide. Conical ends are reduced to 48-inch diameter openings for connection to exhaust piping.

The Lummus Company has built and installed four exhaust-gas aftercoolers for the new altitude-exhaust system for reciprocating and jet engine research facilities of the National Advisory Committee for Aeronautics at the Cleveland, Ohio Airport.

Compressors are used to bring the exhaust gases from simulated stratosphere conditions to atmospheric pressure. The Lummus units cool the exhaust gases to reasonable temperatures for the compressor suctions. Each unit was designed to cool 30,400 lbs. per hour of engine exhaust gas, combined with 7,900 lbs. per hour of water vapor, from 400° to 95°F at 10 inches of mercury absolute pressure.

The units were specially built to meet the exacting conditions of service and to fit the restricted space allotted. Their design permits easy access for inspection and maintenance.

Lummus designs and builds a complete line of heat exchange equipment. For a satisfactory solution to your heat exchange problems, get in touch with The Lummus Company, 420 Lexington Avenue, New York 17, N. Y.

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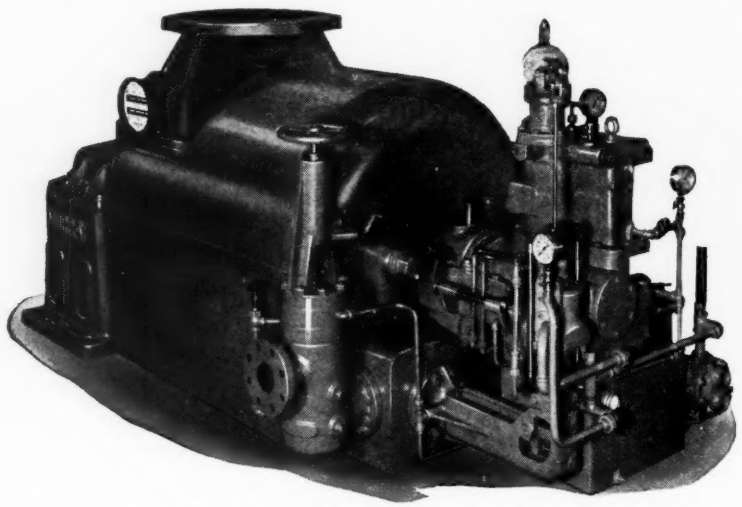
Pipe Line Coolers
Feed Water Heaters
Jacket Water Coolers

Lummus
HEAT EXCHANGER DIVISION



One of two MURRAY multistage steam turbines, designed to deliver 685 horsepower on steam at 110 pounds and exhausting to 26½ inches Hg vacuum, furnished to drive high speed centrifugal compressors for refrigeration in one of the most prominent Southern Hotels. A third unit has recently been shipped. Equipment includes variable speed oil relay governor, trip and throttle valve, strainer surrounding the double seated balanced governor valve, and force feed lubrication.

MURRAY

MULTISTAGE STEAM TURBINES

★ ★ ★ ★

The complete MURRAY line of steam turbines includes all variations of mechanical drives, and turbine generator sets up to and including 3000 KW rating.

Sales Representatives for Murray products are located in all principal cities.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

TAILOR-MADE INDUSTRIAL OIL FIRING

(*Continued from page 103*)

ation. Consequently for large boilers with fluctuating loads many burners must be installed which may be cut in or off as necessary. Another way to follow load variation is to change the the atomizing tips. Naturally attempts are being made to develop burners with a wide range of capacity. The V-C (variable capacity) and the C-D (constant differential) burners are examples of such burners. The latter is shown in Fig. 6. Ranges as high as 20 to 1 with fuel oil pressures up to 900 psi are now being designed.

Horizontal Rotary Cup Burners

A type of burner very popular in the small packaged units, but built also for larger quantities, capable of burning a great variety of liquid fuels, over a fairly wide range, is the rotary-cup burner. The oil is atomized by centrifugal force as it leaves the rim of a horizontal cup rotating at about 3500 rpm. No oil pressure is required. Illustrations show that several designs of this type of burner are available. It may be obtained in a compact unit, with the electric motor driving all at once the oil pump, the rotary cup and the fan supplying the primary air, as in Fig. 7. It may also come as a separate unit, with independent oil supply pump and air blowers as in Fig. 8.

Combination Burners

Figure 9 illustrates one combination pulverized fuel and oil burner, with proper supplies of primary, secondary and also tertiary air, for proper combustion of either one of these two fuels burned in suspension separately or simultaneously. These combination burners, for liquid, solid and gas fuels are extremely popular, for they adapt themselves to the fluctuations of the fuel market. It is essential that the furnaces be designed to suit the requirements of any and all of the fuels used.

Combustion chambers for industrial oil burning cover the entire gamut of designs, solid refractory, air-cooled refractory, and partly or entirely water-cooled with just enough refractory to provide proper ignition. Heat releases follow furnace designs and vary from below 30,000 Btu per cubic foot per hr. to several hundred thousand Btu when adequate cooling is provided.

As the gases from the combustion of residual fuel oils leave the furnace and enter the banks of boiler and superheater tubes, their temperature is reduced and care must be taken to avoid the chilling upon the surface of the tubes of minute portions of slag (in liquid, pasty or vapor state) coming from the salts and ashes naturally present in the crude oil in variable quantities. This difficulty, which can be minimized by improving the quality of atomization and combustion, will have an increasing influence upon the judicious design of boiler and superheater.

The part played by the U. S. Navy in the advancement of boiler firing with

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SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Do your water lines look like this?

Clean water lines quickly, economically, safely the chemical way!

When efficient operation of water lines is the goal—when a full, free flow of water means something in dollars and cents, Dowell's *chemical* cleaning service merits careful consideration.

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Leading railroads, utilities and other industries rely upon Dowell service engineers to perform the entire cleaning operation—bringing with them adequate equipment—special truck-mounted tanks, pumps, mixers, heaters—to control every stage of the successful job. Ask for free booklet—"More Power to America's Industry!" Illustrated in color, it shows how Dowell specialists chemically clean water lines, steam generating equipment, heat-exchangers and many other types of equipment.

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Dowell's industrial engineers are thoroughly experienced in successful chemical cleaning. They are supported by the full research and technical resources of Dowell's own laboratories.

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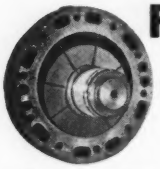
SMALL FLOOR SPACE WITH RELATION TO CAPACITY
MAINTAINED CAPACITY FOR THE LIFE OF THE MACHINE
UNNECESSARY BULK ELIMINATED
NO BEARING TAKE-UP
NO LEAKING VALVES OR GRINDING OF SEATS
NO AIR-LINE PULSATIONS
NO MULTIPLICITY OF PARTS REQUIRING FREQUENT ATTENTION, ADJUSTMENT AND REPLACEMENT

SIMPLE DESIGN...
RUGGED CONSTRUCTION...
EFFICIENT PERFORMANCE



For many years Fuller engineers have striven to build the best compressor money could buy . . . simple in design, easy to operate, ruggedly constructed for long, continuous service at minimum expense. With these thoughts uppermost in mind, it's natural that only the best of materials and workmanship go into the makeup of Fuller Rotaries. Also designed so that when repairs and inspection do become necessary, the work can be accomplished with the least possible effort and minimum loss of time.

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C-136

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

oil cannot be too strongly emphasized. To the Navy also must be given credit for its study of compatibility of residual fuel oils in storage, its adoption of the Heater Test, the Oxidation Test and its setting up of a satisfactory specification for fuel used on board combatant ships. Present specifications of heavy fuel oils are given in the table.

NEWS *from* THE FIELD

MIDWEST POWER CONFERENCE PROGRAM

FOLLOWING is a preliminary schedule of panels and papers of the Midwest Power Conference to be held March 31, April 1 and 2 at the Palmer House, Chicago.

The Conference calls attention to several new features incorporated in the program this year. The Western Society of Engineers, for the first time at these conferences, is sponsoring a luncheon meeting. The inclusion of papers on Diesel power in railroading is another new feature. A third is the session on Metallurgy of Power Plants.

Monday, March 31, 1947

9:00 A.M. Registration, Palmer House.

10:15 A.M. Opening Meeting. Chairman: W. A. Lewis, Illinois Institute of Technology.

(a) Address of Welcome. M. O. Withey, Dean, College of Engineering, University of Wisconsin.
(b) Trends in Electric Power Supply. Colonel H. S. Bennion, Managing Director, Edison Electric Institute.
(c) The Economic Situation of the Present, and What It Presages for the Future. Pearce Davis, Director, Dept. of Business and Economics, Illinois Institute of Technology.
(d) Depreciation Rates. Robley Winfrey, Research Professor of Engineering Valuation, Iowa State College.

12:15 P.M. Joint Luncheon with ASME. Chairman: B. H. Jennings, Chairman, Chicago Section, ASME.
Speaker: Arrangements pending.

2:00 P.M. Central Station Practice. Chairman: D. G. Reid, Chairman, Power & Fuels Div., Chicago Section, ASME.
(Sponsored and arranged by the Power and Fuels Div., Chicago Section, ASME)

(a) Central Station Combustion Control Problems. C. H. Smoot, Republic Flow Meters Co.
(b) Inspection for Safety Power Plant Equipment. Wm. D. Halsey, Chief Engineer, Boiler Div., Hartford Steam Boiler Inspection and Insurance Co.
(c) Discussion.

2:00 P.M. Developments in Heating Chairman: Oliver J. Prentice, C. A. Dunham Co.

(a) Panel Heating with Air. H. F. Randolph, Vice President, International Heater Co.
(b) Baseboard Radiation Developments. W. S. Harris, Dept. of Mechanical Engineering, University of Illinois.
(c) Losses in the Cycle of a Heat Pump Using a Ground Coil. R. A. Budenholzer. Armour Research Foundation of the Illinois Institute of Technology.
(d) Discussion.

3:45 P.M. Diesel Power. Chairman: R. E. Summers, University of Minnesota.

(a) Diesel Developments of Significance. C. G. A. Rosen, Director of Research, Caterpillar Tractor Co.
(b) The Performance of the Diesel Locomotive. A. G. Hoppe, General Supt., Locomotive and Car Depts., Chicago, Milwaukee, St. Paul, & Pacific R.R. Co.
(c) Discussion.

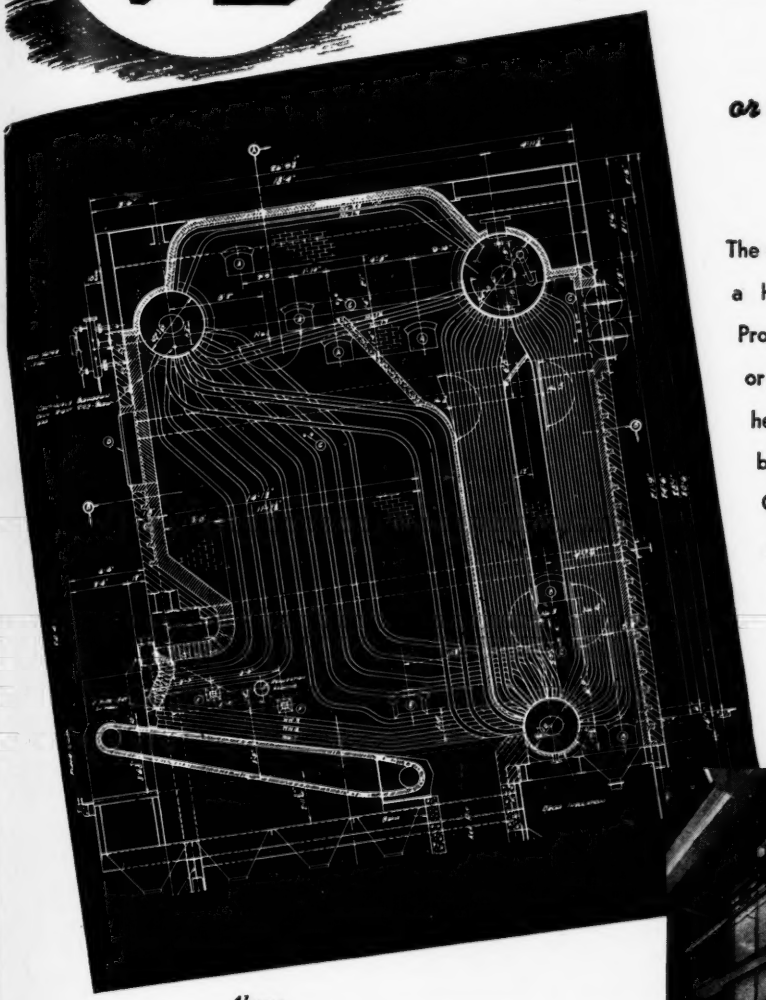
3:45 P.M. Power Supply for Fluctuating

CLASS VL

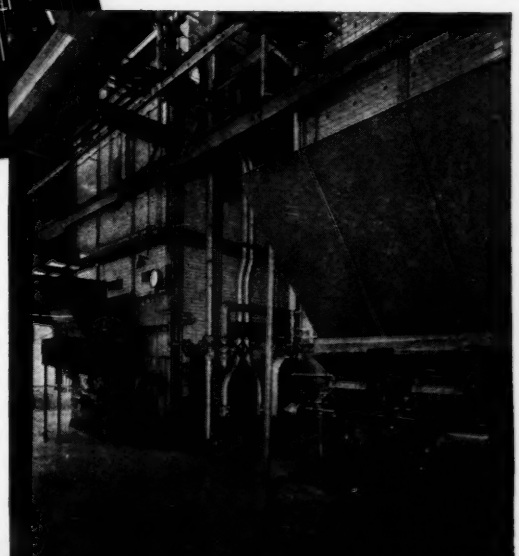
Vogt

Steam Generating Units

for POWER *or* PROCESSING LOADS, *and* HEATING



The design provides large furnace volume and a high ratio of radiant heating surface. Proper combustion is assured with any fuel or method of firing. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Vogt Class VL Steam generating units are giving satisfactory service in Hotels, Sugar Refineries, Steel Mills, Furniture Factories, Distilleries, Oil Refineries, and related industries. A bulletin showing typical installations will be sent upon request.



Above:
This 90,000 lbs. steam per hour unit, designed for 475 lbs. pressure, serves the Mansfield Tire & Rubber Co., Mansfield, Ohio.

Right:
Two 515 H.P. units installed in Brown-Forman Distillers Corporation, Louisville, Ky. Plant.

HENRY VOGT MACHINE CO. • 1000 W. Ormsby St., Louisville 10, Ky.
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THAT'S A *Packing Killer?*

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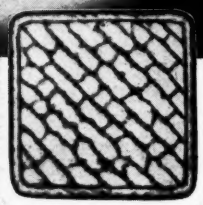

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The patented diagonal construction gives compressibility!

Chesterton "64" is the only asbestos high pressure rod packing with diagonal plies. This construction feature—which replaces the rubber back—means added compressibility and "life", fewer replacements, decreased packing maintenance on steam rod service, superheat, compressed air, gas and hot oil . . . Its special pliable binder, which resists the hardening action of superheat, is another reason for the long and trouble-free service of Chesterton "64" . . . Order a trial box today and get that deep down satisfaction of knowing you're buying the best in asbestos rod packing. Your own dealer, or ourselves, will be delighted to receive your order and see you well started with Chesterton "64".

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"Boiler Repairs Reduced 75%"
writes user of NATIONAL GIRTH SEAM PROTECTOR

We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 928-29 REIBOLD BLDG., DAYTON, OHIO

Loads. Chairman: E. W. Kimbark, Northwestern University.
(a) Power Supply to Fluctuating Loads on a 4000-Volt Distribution System. H. E. Smith, Distribution Planning Engineer, Commonwealth Edison Co.
(b) Industrial Plant Power Distribution System. C. W. Wright, Electrical Engineer, Delco Products Div.
(c) Discussion.

Tuesday, April 1, 1947

9:00 A.M. Power System Loads. Chairman: D. D. Ewing, Purdue University.
(a) Load Statistics of the Electric Light and Power Industry. George L. Jorgensen, Statistician, Commonwealth Edison Co.
(b) Lighting as a Distribution System Load. O. A. Hill, Jr., Public Service Co. of Northern Illinois.
(c) Discussion.

9:00 A.M. Developments in Air Conditioning. Chairman: William Goodman, Illinois Institute of Technology.
(a) Compressors for Air Conditioning. A. B. Newton, Chief Engineer, Airtemp Div.
(b) Postwar Air Conditioning Advances. John Hertzler, Vice President, York Corp.
(c) Discussion.

10:30 A.M. Hydro Power No. 1. Chairman: F. M. Dawson, State University of Iowa.
(a) Keokuk Hydro—A Third of a Century Old. P. L. Mercer, Plant Manager, Union Electric Power Co.
(b) Coordination of Hydro and Steam Power in the Missouri Basin. E. Robert de Luccia, Chief, Bureau of Power, Federal Power Commission.
(c) Discussion.

10:30 A.M. Fuels and Combustion. Chairman: N. A. Parker, University of Illinois.
(a) Energy Sources of Tomorrow. Ralph A. Sherman, Supervisor, Fuels Div., Battelle Memorial Institute.
(b) Methods of Firing Pulverized Coal. (Illustrated by colored motion pictures.) Otto de Lorenzi, Director of Education, Combustion Engineering Co.
(c) Discussion.

12:15 P.M. Joint Luncheon with AIEE. Chairman: L. R. Janes, Chairman, Chicago Section, AIEE.
Speaker: W. C. Johnson, Vice President, Allis-Chalmers Manufacturing Co.

2:00 P.M. Power Cables. Chairman: P. B. Garrett, Chairman, Power Group, Chicago Section, AIEE.
(Sponsored and arranged by the Power Group, Chicago Section, AIEE.)
(a) Aerial Cables for Electric Distribution. George H. Landis, Electrical Distribution Manager, Central Hudson Gas and Electric Corp.
(b) Corrosion of Underground Cable Sheaths Due to Local Cells. L. F. Greve, Commonwealth Edison Co.
(c) Discussion.

2:00 P.M. Small Power Plants. Chairman: M. P. Cleghorn, Iowa State College.
(a) Power for the Paper Industry. Robert Krause, Ass't Plant Manager, Container Corporation of America.
(b) Reduction of Air Pollution from Small Boiler Plants. Parker A. Moe, Gates, Moe & Weiss, Engineers.
(c) Discussion.

3:30 P.M. Electronics in Industry No. 1. Chairman: L. T. Rader, Illinois Institute of Technology.
(a) Good and Bad Electronic Heating Applications in the Wood Industry. John M. Cage, Manager, Industrial Electronics Div., Raytheon Manufacturing Co.
(b) Latest Developments in Electronic Control. W. D. Cockrell, Industrial Engineering Div., General Electric Co.
(c) Discussion.

6:45 P.M. "All Engineers" Dinner. Informal. Grand Ball Room. (Ladies invited.)
Toastmaster: James D. Cunningham, President, Republic Flow Meters Co.
Speaker: Richard R. Deupree, Executive Chairman, Army & Navy Munitions Board, Washington, D.C., and President, The Proctor & Gamble Co.

Wednesday, April 2, 1947

9:00 A.M. Metallurgy of Power Plants. Chairman: Otto Zmeskal, Illinois Institute of Technology.

24 Hours a Day.... 6 Years

DETROIT

JOHN V. WALKER
Commissioner of Public Works

E. W. WILLIAMS, Mayor

JOHN C. ROSE
Commissioner of Finance

Power & Water Department
CITY OF CORBIN
Corbin, Kentucky

Detroit Stoker Company
General Motors Building
Detroit 2, Michigan

Gentlemen:

Replying to your recent letter, we have no objection to your using the pictures of our plant in your new catalog.

Our Detroit RotoStoker, installed in 1940, has been in almost continuous twenty-four hour per day operation for the past six years. We have not had one single outage due to stoker trouble and our maintenance expense has been very low.

Your RotoStoker is certainly dependable and operates with high efficiency.

Yours very truly,

Electric Power and Water Department

H. C. Craft

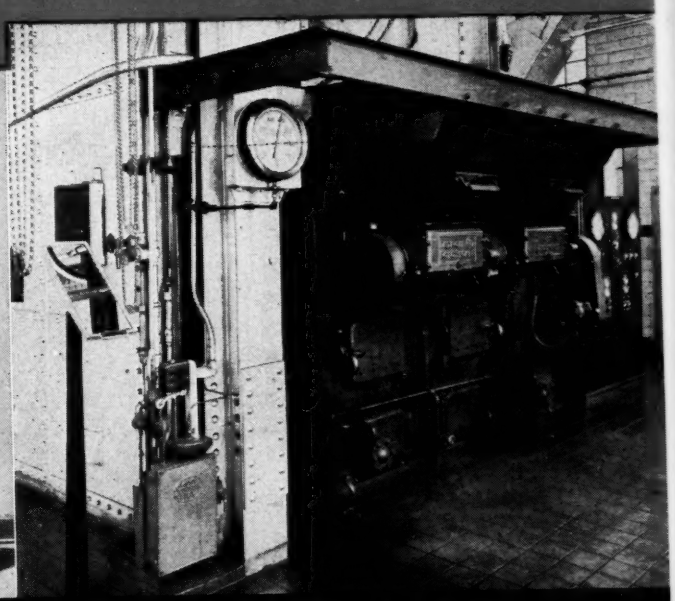
H. C. Craft, Superinte

HCC:mp

READ WHAT THIS CUSTOMER *Says...*

ROTOSTOKER

The Detroit RotoStoker—an overthrow spreader type stoker — will burn most types of coal, handle widely fluctuating loads and give you availability plus.

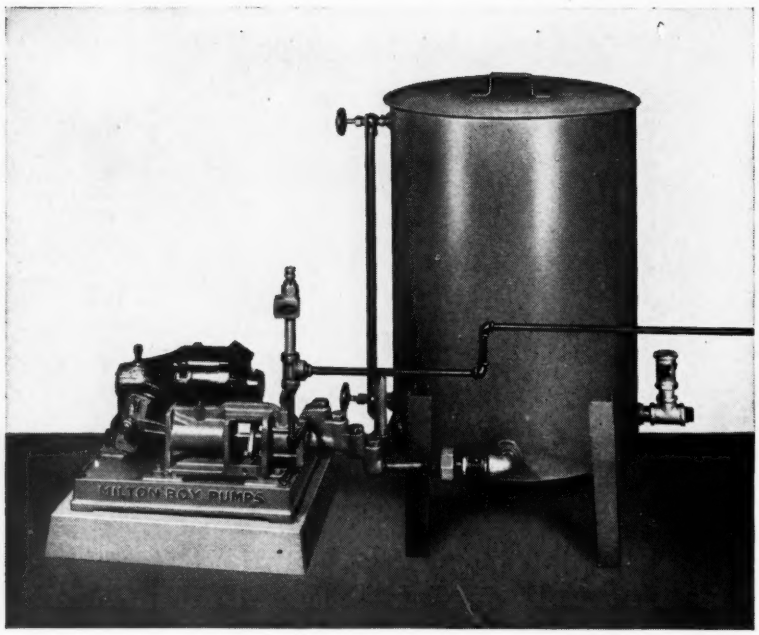


DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

District Offices in Principal Cities • Works at Monroe, Michigan

Complete *"Packaged Units"* for Chemically Treating Boiler Water



- **To remove dissolved oxygen, insure against corrosion and prevent pitting.**
- **To prevent scale formation, control alkalinity and prevent embrittlement.**

Milton Roy "Packaged Units" are available in two types, to feed Sodium Sulfite into the suction side of the feed water pump and to feed other treating chemicals, such as phosphates, soda ash and caustic, directly into each boiler. Both methods are usually necessary for the correct chemical treatment of boiler water.

These units are complete, with Milton Roy Pumps, tanks, gage glasses, low level pump cut-outs and alarms. The pumps are standard Milton Roy units. Volume of treating chemicals may be controlled precisely. Solution tanks from 50 to 500 gallons capacity are furnished. Completely automatic controls, with meters, can be supplied to operate pumps at rates proportional to the rates of feed water flow. Units are available in a wide range of capacities and to meet all pressure requirements.

For complete description of these "Packaged Units," with flow diagrams, specifications, selection tables, etc., write for Bulletin No. 451. Ask also for Technical Paper No. 51 "What the Power Engineer needs to know about Chemical Feed Systems for Water Treatment," and our new pump catalog No. 146.

MILTON Roy COMPANY

1332 E. MERMAID AVE., CHESTNUT HILL, PHILA. 18, PA.

(a) Metallurgical Considerations in H.T.-H.P. Piping Layouts. J. J. Kanter, Materials Research Engineer, Crane Co.
(b) Materials as a Consideration in Modern Boiler Feed-Pump Construction. Hugh Ross, Chief Engineer, Centrifugal Pump Dept., Allis-Chalmers Mfg. Co.
(c) Discussion.

9:00 A.M. Electronics in Industry No. 2. Chairman: E. B. Kurtz, State University of Iowa.
(a) Electronics in Power and Process Instrumentation and Control. C. H. Barnard, Application Engineer, Bailey Meter Co.
(b) Power Line Carrier Current Equipment. R. C. Cheek, Central Station Division, Westinghouse Electric Corp.
(c) Discussion.

10:30 A.M. Hydro Power No. 2. Chairman: Ben Elliott, University of Wisconsin.
(a) Correlation of Hydro-Plant and Steam-Plant Operation. Vincent Thieman, Wisconsin Public Service Corp.
(b) Discussion.

10:30 A.M. Feedwater Treatment. Chairman: L. G. Miller, Michigan State College.
(a) Demineralized Water. Lyle B. Porter, Director of Research Illinois Water Treatment Co.
(b) Removal of Carbon Dioxide from Alkaline Waters. Arthur E. Kittredge, Vice President and Chief Engineer, Cochrane Corp.
(c) Discussion.

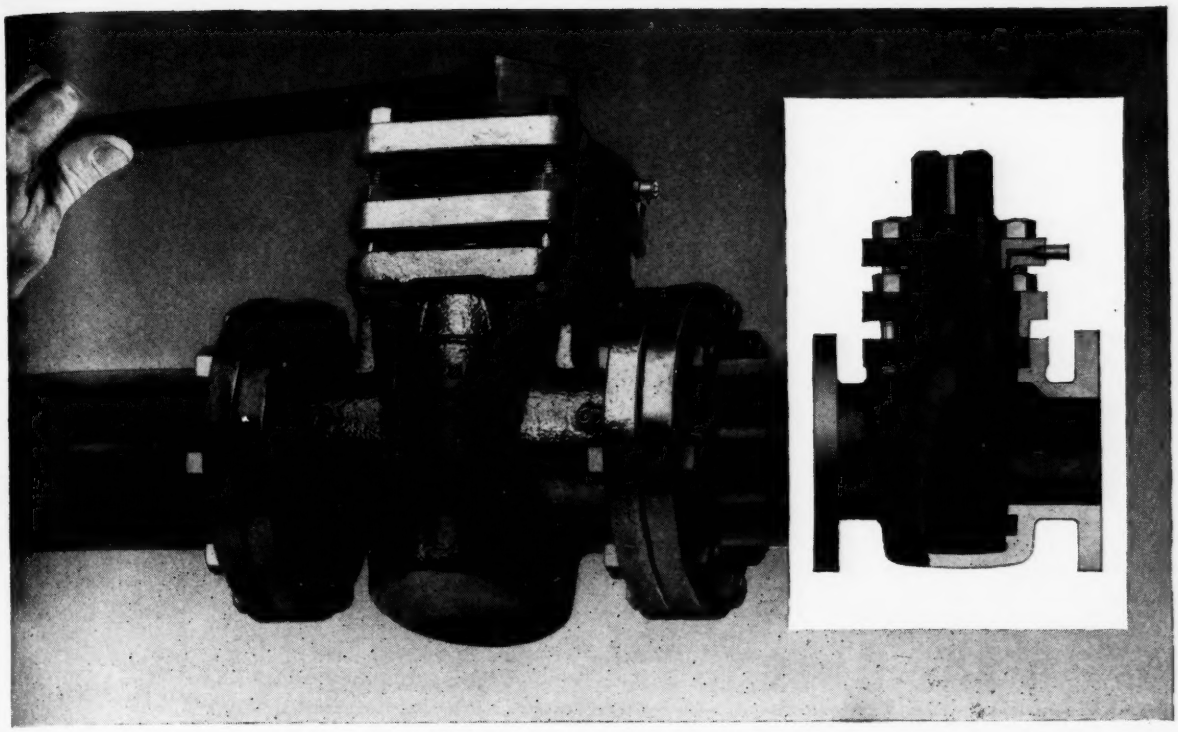
12:15 P.M. Joint Luncheon with WSE. Chairman: Titus G. LeClair, President, Western Society of Engineers.
Speaker: Preston T. Tucker, President, Tucker Corp.

2:00 P.M. General Session. Chairman: Herman Halperin, Chairman, Civic Committee, Western Society of Engineers.
(Sponsored and arranged by the WSE.)
Subject: Increasing the Engineers' Contribution to Civic Progress.
Speakers:
Mayor Edward J. Kelly, City of Chicago.
R. M. Gates, President, Air Preheater Corp.
Joseph D. Lohman, Lecturer in Sociology, University of Chicago, and Director of Race Relations, Julius Rosenwald Fund.

3:30 P.M. Gas Turbines. Chairman: John T. Rettaliata, Illinois Institute of Technology.
(a) Where Will the Gas Turbine Fit as a Stationary Power Plant? L. N. Rowley, Managing Editor and B. G. A. Skrotzki, Associate Editor, Power.
(b) Recent Gas Turbine Developments at Brown-Boveri. Paul R. Sidler, President, Brown-Boveri Corp.
(c) The Coal-Burning Gas Turbine Power Plant. John I. Yellott, Director of Research, Locomotive Development Committee.
(d) Discussion.

3:30 P.M. Transmission and Distribution. Chairman: J. S. Gault, University of Michigan.
(a) Unit Substations for Distribution Systems. R. L. Witzke, Central Station Engineer, Westinghouse Electric Corp.
(b) Six-Year Operating Record of Transmission Lines Designed for Improved Performance Under Lightning Conditions. E. W. Oesterreich, Superintendent of Distribution, Duquesne Light Co.
(c) Electric Power—Its Relation to National Security. John W. Swaren, Research Analyst, Industrial College of the Armed Forces.
(d) Discussion.

Three luncheons and one dinner are on the program: Luncheon, 12:15 pm, Monday, March 31, $3.50; All-Engineers Dinner, 6:45 pm, Tuesday, April 1, $4.50; Luncheon, 12:15 pm, Tuesday, April 1, $3.50; and a luncheon 12:15 pm, Wednesday, April 2, $3.50. Conference Secretary is Edwin R. Whitehead, Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill.



EASIER WORKING, LONGER LASTING READING-PRATT & CADY A. P. COCKS

Asbestos-Packed Cocks serve best as a shut-off on lines that carry solids in suspension, viscous fluids, oils, etc.,—in short, where Globe, Angle or Gate valves fail or where conventional ground plug cocks prove unsatisfactory. R-P & C A. P. Cocks are made in cast iron, bronze and cast steel.

READING, PA.—U-shaped grooves in the body of this cock are packed solidly with asbestos, which is then vulcanized. This provides a bearing surface which absorbs expansion and results in easier operation by avoiding the friction of metal-to-metal contact.

Double Gland Feature

This feature shown in the illustration, results in easier operation and longer life than the Single Gland Asbestos Packed Cock. With it the plug is not jammed down unnecessarily by putting appropriate pressure on the top packing.

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Reading-Pratt & Cady offers you a single responsible source for bronze, iron and steel globe, angle and check valves—Lubrotite gate valves—Bar Stock valves—cast steel fittings.

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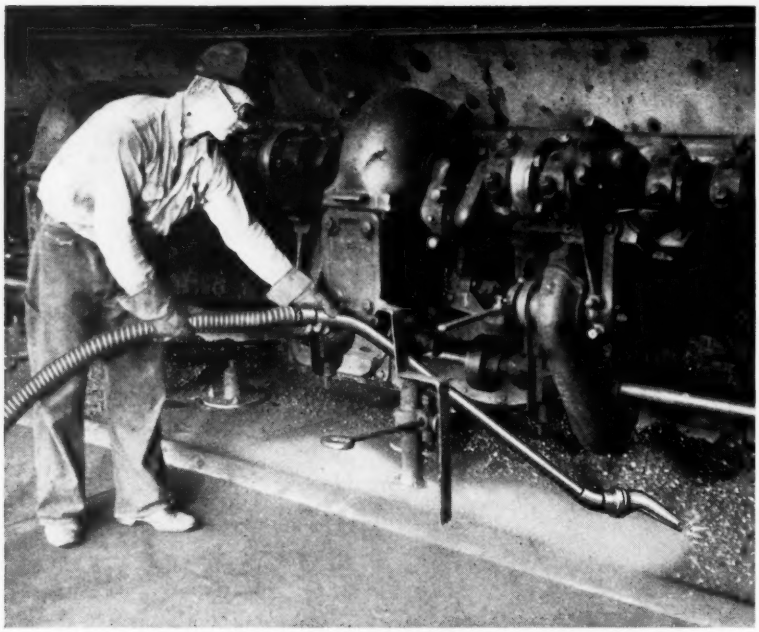

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In plant after plant Hoffman Vacuum cleaning equipment is eliminating both the explosion hazards of coal dust deposits and the health hazards of ash dust accumulations. Vacuum cleaning provides a quick and easy method of keeping your plant clean because the dust is actually removed without scattering up clouds of fine dust to settle elsewhere.

Hoffman Vacuum equipment enables you to keep down overhead dust accumulations, do a more thorough cleaning job with less work and improves your working conditions.

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NDHA TO MEET

THE 38TH Annual Meeting of the National District Heating Association will be held at The Ambassador Hotel, Atlantic City, N.J., June 16 to 19 inclusive, 1947.

LUBRICATION ENGINEERS COMPLETE PROGRAM

THE AMERICAN Society of Lubrication Engineers is rapidly completing its program for the second annual convention of the Society to be held March 17, 18 and 19, 1947, at the Hotel William Penn in Pittsburgh.

An outstanding series of technical papers will be presented at the four Technical Sessions with luncheon meetings and a Smoker and Banquet being scheduled respectively for the evenings of March 17 and March 18.

Among the speakers at the Technical Sessions of the convention are Dr. T. C. Poulter of Armour Research Foundation who will speak on "The Use of Extreme Pressure in the Study of Lubricating Oils," H. Y. Hunsicker of the Aluminum Co. of America who will speak on "New Developments in Aluminum Alloy Bearings," E. H. Erck, Bendix Aviation Corp., who will speak on "Instrument Lubrication," John Boyd of the Westinghouse Electric Corp. on "Jet Engine Bearings," and Eugene Lieber of the Nox-Rust Chemical Corp., who will speak on "Mechanism of Preservation in Engine Oils."

In addition to other papers, a session will be devoted to the position that management might well take in regard to lubrication in industry.

PROGRAM OF REFRIG., A.C. SHOWS ANNOUNCED

A PERMANENT, far-reaching policy of national refrigeration and air conditioning expositions, centering around the holding of one all-industry show every two years beginning in January, 1948, was announced today by the Refrigeration Equipment Manufacturers Association.

The program was voted unanimously by directors of the association following an analysis of the results of the Fourth All-Industry Refrigeration and Air Conditioning Exposition in Cleveland last fall which was three times larger in size and attendance than any other comparable event in the industry's history.

Inaugurating the new policy will be the Fifth All-Industry Exposition, which will be held in the Cleveland Public Auditorium, January 26, 27, 28 and 29, 1948, under the sole sponsorship of REMA. Thereafter, REMA will sponsor exhibitions every two years, an event already having been scheduled for January, 1950.

FELT STANDARDS AMENDED

IMPLYING expanded use of wool felt in industry, it is announced that the felt standard of the Society of Automotive Engineers is being amended commensurate with post-war commercial practice, as recently coded by the manufacturers of this material, through the Felt Association. The SAE felt standard was last revised in 1940. In the interval since that time many new uses have developed for it, especially in connection with the military program and currently in newly designed commercial products.

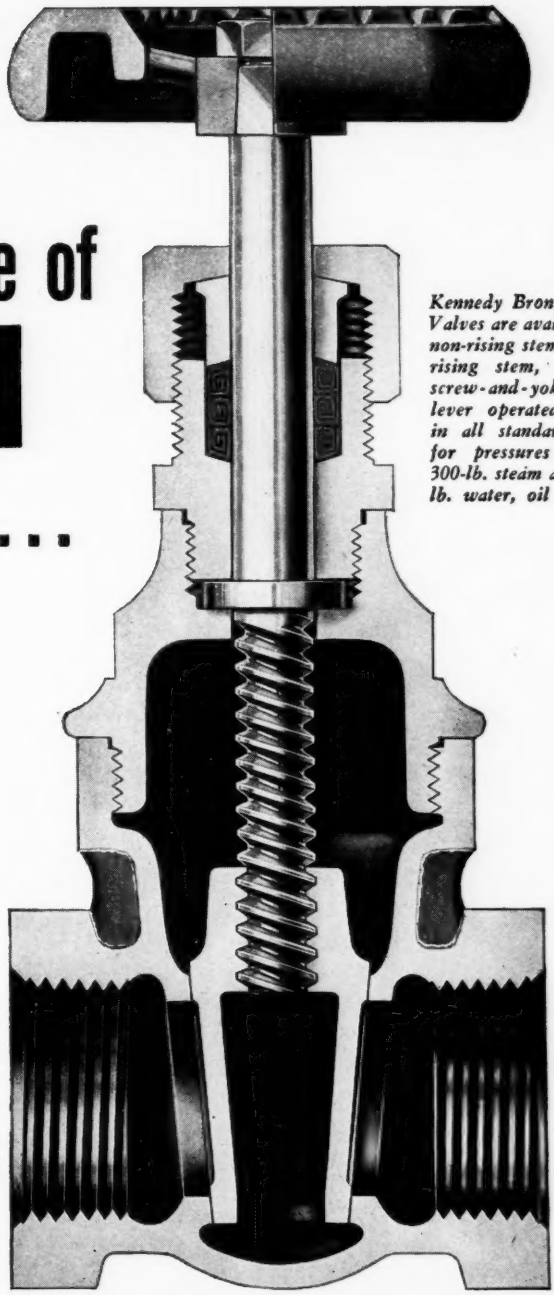
FISKE RESIGNS AS SECRETARY OF ASRE

ANNOUNCEMENT was made recently by The American Society of Refrigerating Engineers of the resignation of David L. Fiske, Secretary of that organization since 1927.

Mr. Fiske has been for years an active figure in the industry. His work for the Society included founding and editing the Refrigerating Data Book, from its first edition in 1932. He has assisted in the formation of many of the sections of the ASRE and in the work of its standardization and other technical projects. Members of this Society will remember his participation in its many meetings.

This... on the outside

is your assurance of lasting service on the inside .....



Kennedy Bronze Gate Valves are available in non-rising stem, inside rising stem, outside-screw-and-yoke, and lever operated types, in all standard sizes for pressures up to 300-lb. steam and 600-lb. water, oil or gas.

It's no secret—Kennedy Valves give long, trouble-free service because every part is designed for maximum life. Take this bronze gate valve, for instance. Note the large bonnet hexes close to the body. That prevents body distortion. See the large number of heavily proportioned stem threads . . . the simple, strong, accurately guided disc.

Look at *any* valve that has Kennedy on the outside. You'll find an abundance of long life features . . . all of them fully described in Kennedy's 240-page Catalog, along with complete information on Kennedy bronze and iron-body gate, globe, angle and check valves, pipe fittings and flanges, and other valves and accessories. Write for your copy today.

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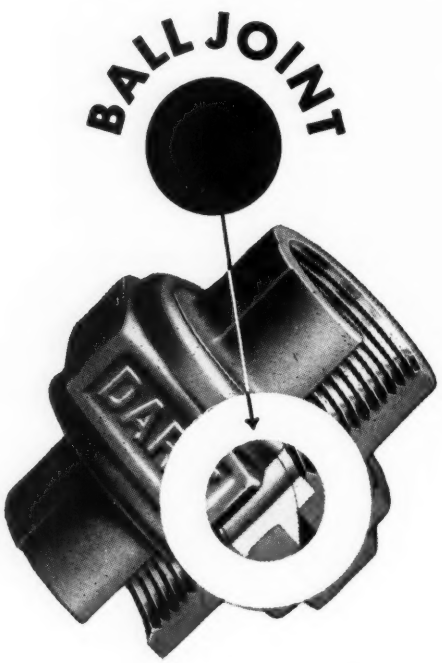
KENNEDY valves-pipe fittings-fire hydrants

THE KENNEDY VALVE MFG. CO., ELMIRA, NEW YORK *Offices and Warehouses in Principal Cities*

Bronze to Bronze

Seated in a True



Makes Dart Unions

•FIT TIGHTER •LAST LONGER

•COST LESS

Because its two bronze seats are precision-ground to form a true ball joint, the Dart Union makes a drop-tight connection without excessive wrenching. It uncouples just as easily—may be used over and over again wherever needed—is thus the least inexpensive in the long run. Made of high-test air-refined malleable iron, it is practically unbreakable. Ask your supplier to demonstrate Dart.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE 5, R. I.

MEANING OF "FLEXONICS" EXPLAINED BY C.M.H.

"FLEXONICS," according to an announcement by the Chicago Metal Hose Corp., Maywood, Ill., is defined as "the science of controlled bending of thin metals for use under varying conditions of temperature, pressure, vibration and corrosion." The word "Flexonics," like electronics, the company explains, is pertinently descriptive. This newly coined word has particular reference to the art of manufacturing flexible metal hose. As C.M.H. officials point out, "Flexonics" is a combination of many skills, all stemming fundamentally from three major segments of the manufacturing plan.

The first of these is research. Research, in the case of Chicago Metal Hose, has meant over 44 years spent in the careful investigation of both present and projected future flexible metal hose requirements.

The second part of the Flexonics structure is development. Here the first steps taken in the research laboratories are carried forward, all energies being devoted to the further improvement of all types of flexible metal hose essential to industry.

Flexonics, finally, means a knowledge of installation requirements . . . a study which reveals how flexible metal hose can be most efficiently used . . . thus permitting proper fabrication for the required installation.

"BETTER CUSTOMER SERVICE" THEME OF ALLIS-CHALMERS MEET

A LONG-RANGE program for continued and improved customer service was the central theme at a recent Allis-Chalmers Mfg. Co. general machinery division conference of district office managers and company executives in Milwaukee.

W. C. Johnson, vice president in charge of the general machinery division, announced an important change in the division's field organization, a change aimed at furthering customer service.

Mr. Johnson revealed that the district offices would be grouped, according to location and similar interests, under the direction of regional managers. The regional managers each will have a staff of specialists, and the regions will operate as self-contained field units.

At the same time announcement was made of the appointment of the first regional managers who will act as nucleus for building the first four regional organizations. The appointments announced were W. F. Taylor, D. S. Kerr, and J. L. Pratt, as well as A. J. Schmitz who will continue in that capacity.

Mr. Taylor will supervise the New England area; Mr. Kerr will handle the Southeast; the Southwest will be supervised by Mr. Pratt, while Mr. Schmitz will continue to direct operations in the Pacific coast area.

BURNS & McDONNELL EXPANDS

BURNS & MCDONNELL Engineering Co., in its 49th year of consulting engineering work, has enlarged its firm membership from the present four members—R. E. McDonnell, C. A. Smith, R. L. Baldwin and R. H. McDonnell—to eight. The four new members were selected from the Senior Associate Engineers and are:

Arthur F. Hartung, Electrical Engineer, graduate of the University of Kansas, member of the American Institute of Electrical Engineers, spent three years with the General Electric Co. He came to Burns & McDonnell 18 years ago and specializes in electrical and power design.

Russell G. Kincaid, Civil and Hydraulic Engineer, graduate of the University of Missouri, member of the American Society of Civil Engineers, American Water Works Association, and National Society of Professional Engineers, has been with the firm for 20 years and specializes in hydraulic work.

C. Kelsey Mathews, Civil Engineer, graduate of the University of Kansas, served three

A New

EVERLASTING

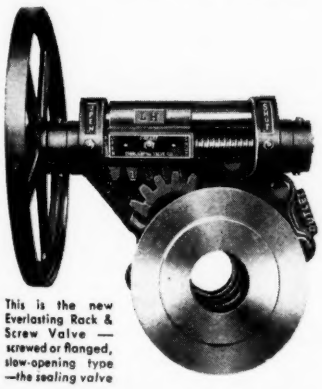
DUPLEX UNIT

for dual safety in blow-off service

Here's an EVERLASTING valve team that's sure of a cordial reception by engineers!

This new EVERLASTING Duplex Blow-off Unit provides dual safety—plus extreme durability—obtained by coordinating the respective merits of two highly efficient EVERLASTING Blow-off Valves.

✓ Check these combined advantages



This is the new Everlasting Rack & Screw Valve — screwed or flanged, slow-opening type —*the sealing valve*

The Sealing Valve

✓ Unimpeded straight-through flow — at full pipe-line capacity

✓ Self-grinding action of disc across seat keeps valve constantly self-lapped to microscopic precision—a drop-tight seal always assured

✓ Non-wedge construction — valve cannot jam or stick

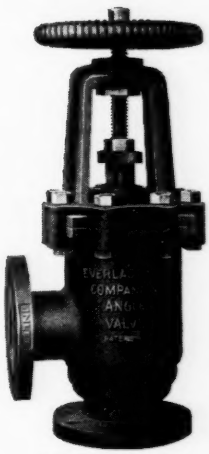
The Blowing Valve

✓ Built stoutly — to withstand shock of the blow-off force

✓ Built of tough materials — to resist erosion and abrasive action of solids in blow-off water

✓ Built without pockets — to prevent lodgement of solids

✓ Built to seal drop-tight — and stay that way



This is the Everlasting Angle Valve—*for taking the blowing force*

In dual operation these EVERLASTING Valves have what it takes to render dual safety in blow-off service . . . and they keep on doing it! And for ease of operation, positive blow-off action, drop tight seal, dependability and long life, this new EVERLASTING Duplex Blow-off Unit is unsurpassed. It has already set new standards of performance in blow-off service!

These valves fully meet all boiler blow-off code requirements. Either valve available separately.

Ask your distributor **— or write directly to us—*for complete information.***

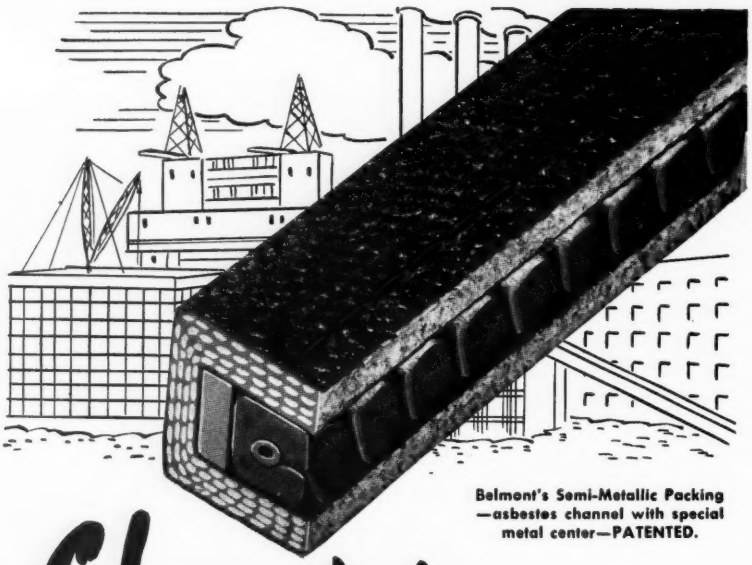
EV-318

EVERLASTING VALVE COMPANY

49 Fisk Street, Jersey City 5, N. J.

Trade-Mark "EVERLASTING"—REG. U. S. PAT. OFF.

EVERLASTING VALVES give "everlasting" service!



Belmont's Semi-Metallic Packing —asbestos channel with special metal center—PATENTED.

Closest to Friction*less Seal

Soft metal volutions which bulge toward the rod under gland pressure make Belmont's No. 865 Semi-Metallic Packing the ideal seal for high-pressure steam rods, valve stems and air compressor rods. It's a tight, metal-to-metal, practically friction-less seal.

The unique, spirally-wound metal is encased in a stitched asbestos channel The packing is so flexible that it can be formed around small diameters.

Have your Belmont distributor furnish you with Belmont's 865 (ring form) or 866 (spiral form). For low pressure steam, hot and cold water rods and plungers and ammonia rods, specify Belmont 860 (ring) or 861 (spiral)—same as 865, with stitched rubber-and-duck channel on three sides.

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

IN THE BLUE-AND-ORANGE BOX

THERE IS A BELMONT PACKING FOR EVERY SERVICE . . . Belmont distributors are located in every large industrial center, ready to give you prompt delivery from local stocks.

6 New Folders

Write us for new folders on Belmont Centrifugal and Rotary Pump Packings, Flax Packings, Hollow Center Packings, Oil and Gasoline Packings, Rod Packings, Sheet Packings.

THE BELMONT PACKING AND RUBBER CO.

Butler and Sepviva Streets

Philadelphia 37, Pa.

years as instructor in Civil Engineering at the University of Illinois, member of the American Society of Civil Engineers and American Water Works Association, came to the firm 24 years ago, and specializes in appraisals and sanitary works.

Earl J. Thomson, Electrical Engineer, graduate of Manitoba and Marquette universities, member of the American Society of Civil Engineers, served four years as Acting and Assistant City Engineer at Moose Jaw, Sask., Canada. He came to the firm 11 years ago and specializes in water works, sewage treatment, and power plants.

Beginning January 1, 1946, the firm adopted a policy of profit sharing with its 75 employees, on a basis of salary and seniority. Burns & McDonnell Engineering Co. hopes to celebrate its fifty years of engineering in a new modern air-conditioned building to be erected on a tract of land acquired at 51st and Brookside Boulevard, Kansas City, Missouri.

COMING EVENTS

Power Conference—1947 annual meeting, Midwest Power Conference; to be held March 31, April 1 and 2 in Chicago, with headquarters at the Palmer House.

Society for Experimental Stress Analysis—Annual meeting of the SESA; to be held May 15 through 17, with headquarters at the Hotel Stevens, Chicago.

American Society of Lubrication Engineers—Second annual convention of the ASLE; to be held May 17 through 19, with headquarters at the Hotel William Penn in Pittsburgh.

Oil and Gas Power Division of ASME—The 19th Annual Conference of the Oil and Gas Power Division of the ASME; to be held in Cleveland, May 21 through 24, with headquarters at the Hotel Statler.

Stoker Manufacturers—Annual meeting of the Stoker Manufacturers' Association to be held June 16, 17 and 18; headquarters to be at Lookout Mountain Hotel, Lookout Mountain, Tenn.

National District Heating Association—38th Annual Meeting of the NDHA; to be held June 16 through 19 with headquarters at the Ambassador Hotel, Atlantic City, N.J.

ASTM—1947 Annual Meeting; to be held in Atlantic City, June 16 through 20, with headquarters at Chalfonte-Haddon Hall.

Instrument Society—Instrument Society of America annual meeting; to be held the week of September 8, 1947, with headquarters at the Stevens Hotel, Chicago.

Instrumentation Conference—Instrumentation Conference and Exhibit for 1947; to be held the week of September 8, with headquarters at the Stevens Hotel, Chicago.

Refrigeration and Air Conditioning Exposition—Fifth All-Industry Exposition; to be held January 26 through 29, 1948 with headquarters at Cleveland Public Auditorium, Cleveland, Ohio.

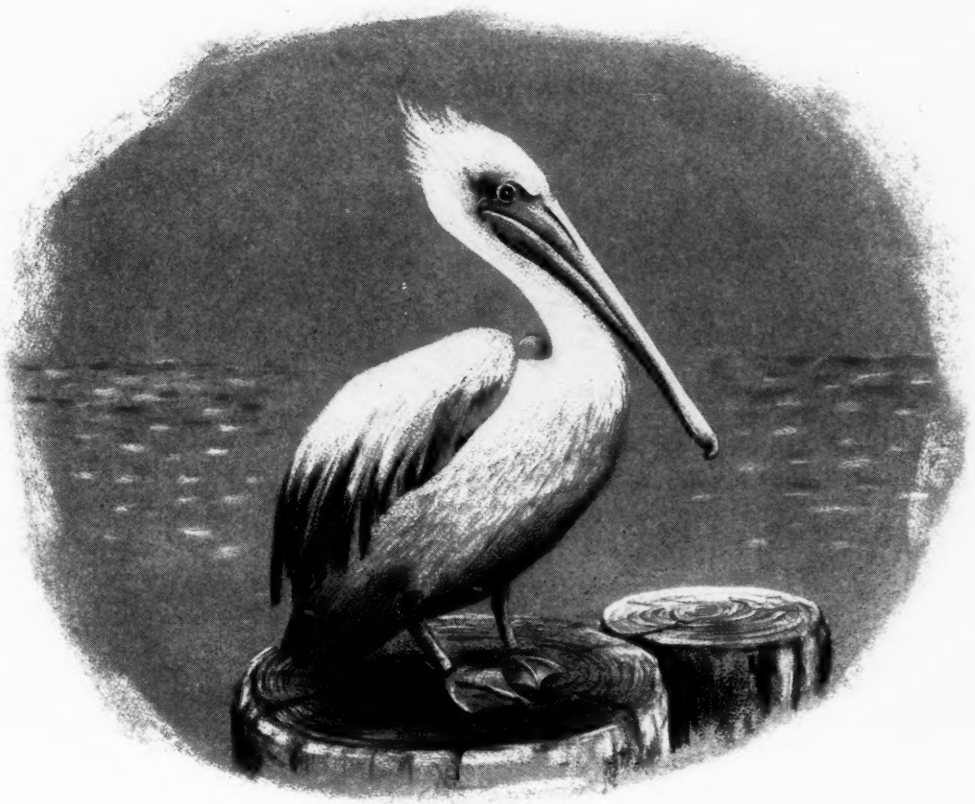
MANUFACTURERS' *Personals*

NEW APPOINTMENT BY ELGIN SOFTENER

Elgin Softener Corp. has announced the appointment of Elwood W. Scarritt as Assistant General Manager.

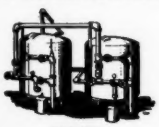
Mr. Scarritt graduated from the University of Illinois in 1924 with an A.B. Degree in Science. Following his graduation he received an M.S. Degree in the field of water purification at the University.

Prior to joining the Elgin staff, Mr. Scarritt was connected with the technical staff of the Paige & Jones Chemical Co., where he was

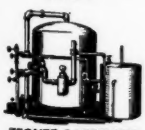


pH TO A PELICAN IS NONSENSE

HOT PROCESS SOFTENERS



FILTERS



ZEOLITE SOFTENERS

REACTIVATORS

To a pelican, any water containing an ample supply of fish is satisfactory . . . pH ratings are a lot of nonsense.

pH, on the other hand, is one of the factors taken into consideration by Graver engineers in the design of your zeolite water softener, for the selection of the proper zeolite depends directly upon its durability as to pH rating. Building a water conditioning plant to do *exactly* the job you require, process or boiler feed, demands that such details be given careful attention if the plant is to operate economically and efficiently.

This attention to detail has played an important part in Graver's thirty-five years of design, fabrication and erection of every type of water conditioning equipment. Why not take advantage of it on your next job?

GRAVER TANK & MFG. CO., INC.

General Offices: East Chicago, Indiana

New York Philadelphia Chicago

Water Conditioning and Process Equipment Division

GRAVER

in charge of chemical research and special production problems in the field of water conditioning.

In rounding out 20 years of service with the Elgin Softener Corporation he is well qualified for his new duties. He has risen successively from Chief Chemist, Chemical Director, and Industrial Sales Manager to his present position. For the present he will continue to act as Industrial Sales Manager of the Corporation in addition to his assistant managerial duties.

FLESHER NEW SALES MGR. FOR CONDENSER SERVICE

CARL W. FLESHER, Pacific Coast regional director of construction for the U. S. Maritime Commission from 1942 to 1946, has become sales manager of the Condenser Service & Engineering Co., Inc., Hoboken, New Jersey, according to a recent announcement.

Graduating from the U. S. Naval Academy in 1927, Mr. Flesher served three years at sea with the Navy before joining the marine sales department of the Westinghouse Electric Corp. In 1938 he left Westinghouse to become associated with the U. S. Maritime Commission in Washington, and in 1942 he was transferred to Oakland and placed in charge of the Commission's wartime shipbuilding program on the Pacific Coast, serving in that capacity throughout the entire war. Mr. Flesher will make his headquarters in Hoboken, and will have charge of all the company's sales activities.

STURTEVANT OF MANHATTAN RUBBER RETIRES

WALTER L. STURTEVANT, chemical engineer at the Manhattan Rubber Division plant, Raybestos-Manhattan, Inc., Passiac, N.J., was honored on his retirement at a dinner December 17 at Robin Hood Inn, Clifton, N.J. More than 100 friends and co-workers attended.

Mr. Sturtevant had been chemical engineer since 1931 and had represented Manhattan on various government and scientific committees. Before 1931 he was chief chemist and assistant superintendent in charge of laboratory, mill and calendar departments. He was appointed to that post in 1917, five years after he joined the firm as a chemist. He was instrumental in creating and building Manhattan laboratories which are believed the most extensive and modern for a mechanical rubber company. He also modernized Manhattan's compound and calendar departments.

BEANE NEW SALES MANAGER OF BRISTOL

H. E. BEANE has been appointed General Sales Manager of The Bristol Co., Waterbury Conn., according to a recent announcement. He wil ltake up his new duties January 2 1947.

Starting as a sales engineer, Mr. Beane has been associated with The Bristol Co. since 1920. From 1925 to 1935, he was District Manager of various branch offices of the company. He became field sales manager in 1936, and sales manager in 1943.

J. Robert Ferguson, Jr., has been appointed assistant chief engineer of the South Chicago plant of Carnegie-Illinois Steel Corporation, a U. S. Steel subsidiary. He succeeds H. L. Lietz who has been appointed chief design engineer. Mr. Ferguson has been in the corporation's engineering department since 1940 and has served in both the Pittsburgh and Chicago districts.

G. Lawton Johnson has been appointed assistant general manager of sales of National Tube Company by H. J. Wallace, general manager of sales of this U. S. Steel subsidiary. Mr. Johnson will handle the sale of products manufactured at Christy Park Works, McKeesport, Pa., and some of the company's other fabricated products.

Curtis H. Stout, 1808 Beechwood Road, Little Rock, has been appointed by Weston Electrical Instrument Corp., Newark, N.J., as its sales representative for the territory consisting of Arkansas, western Tennessee, northern Mississippi and northern Louisiana.

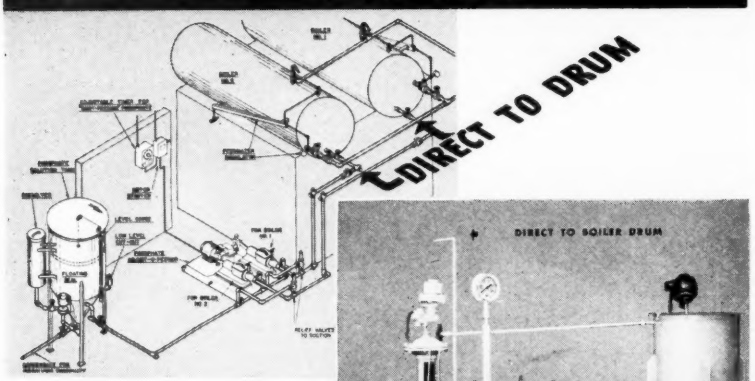
Condenser Service & Engineering Co., Inc., Hoboken, N.J. has been awarded a contract for constructing and installing three 70,000 sq ft condensers for the Wilmington Harbor Plant of the City of Los Angeles, Calif. This is believed to be one of the largest single condenser jobs for a public utility that has ever been awarded to one company.

Charles V. Carroll of Minneapolis, has joined the engineering staff of the Detroit Stoker Co. it has just been announced. Mr. Carroll is a Combustion Engineer of wide experience, and will make his headquarters at the Minneapolis office of the Detroit Stoker Co., 1249 McKnight Building—Telephone Geneva 3012. For many years Mr. Carroll has been active in power plant equipment in the North Central section of the United States and is familiar with the various types of fuel customarily burned in that section.

Howard C. Josephson has been appointed General Sales Manager of Greene, Tweed & Co. and will play an important role in an ambitious program of expansion, it was announced recently by the company. Mr. Josephson formerly was assistant to the President of Clark-Babbitt industries and was responsible for the organizing of distribution for the Aluminum Building Products Division of Reynolds-Metals which has been recently introduced to readers of large daily newspapers.

In addition to an outstanding record in the United States in which he won an award from the Chamber of Commerce, Mr. Josephson has also had considerable sales success in Canada and England. He is a past President of the St. Louis Chapter of Society of Plastic Engineers and a national director of the society.

Check Boiler Corrosion and Scale
with %PROPORTIONEERS% DIRECT-TO-DRUM
CONTINUOUS or INTERMITTENT INJECTIONS



Feed the PROPER treating chemical
to the APPROPRIATE place
in the CORRECT proportion
at the RIGHT time

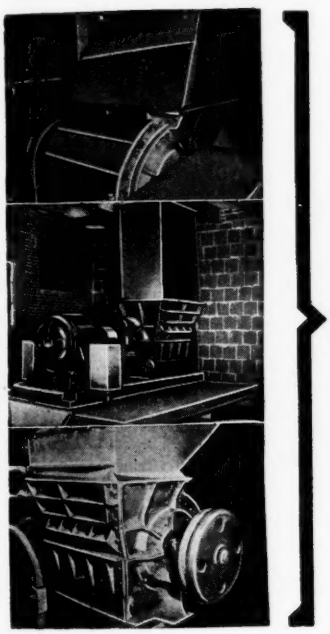
%PROPORTIONEERS% boiler water treating equipment automatically injects phosphates and other internal treatment direct to the drums of medium and high pressure boilers in accordance with the steaming rate of the individual boilers. Feeding is accurately controlled and the system is automatically flushed after each feeding period. %Proportioneers% offer standardized accessories and equipment for complete boiler water conditioning systems including equipment for control of oxygen in feedwater.

Ask us for complete specifications.

% PROPORTIONEERS, INC. %

WRITE % PROPORTIONEERS, INC. % 46 CODDING ST., PROVIDENCE 1, R. I.
Technical service representatives in principal cities of U. S. A., Canada and Mexico

1947 DESIGN FOR MORE EFFICIENT COAL PREPARATION



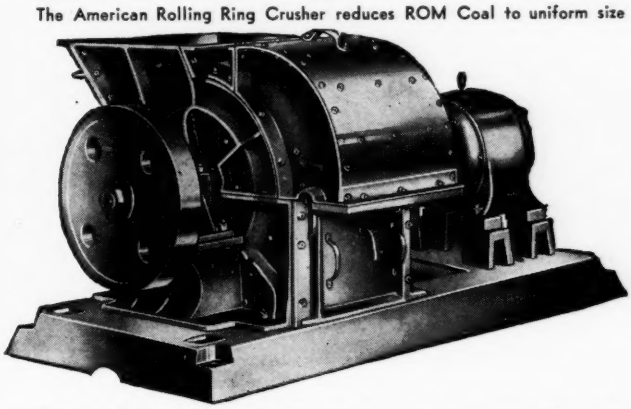
Changing over to Americans is easy because of their minimum headroom requirements and independence from auxiliary equipment.

AMERICAN *Rolling Ring* CRUSHERS

Reduces up to 500 TPH at less than 1c per ton!

With the constant demand for more kilowatt output, getting the most BTU's from each pound of coal is directly related. Here's where coal preparation enters into the efficiency of power production and that's where the American Crushers can improve your efficiency.

The American Rolling Ring Crusher reduces ROM Coal to uniform size for efficient firing.



The basis for greater crushing efficiency is the manganese shedder rings — exclusive with American.

The patented shredder ring action of Americans, through splitting instead of crushing coal, results in a uniform product with controlled fines. For stoker feed sizes down to ¼" fines are minimized to the point that subsequent screening is not required to obtain a product that permits a loose firebed that responds to sudden steam demands—admits oxygen for efficient burning and yet does not have excessive ashpit drop.

The fineness to which Americans will grind pulverizer sizes without oversize reduces the load on the ball grinders and increases preparation efficiency in pulverizer feed operations.

The American bulletin "Crushing Coal For Less Than 1c Per Ton" is yours for the asking. Write for it.

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 MACKLIND AVE.
ST. LOUIS 10, MO.

Donald A. MacNeil has joined the sales staff of the forging division of Tube Turns (Inc.), Louisville, Ky., it is announced by John G. Seiler, the firm's vice president and general sales manager. He will make his headquarters in Chicago, in the Utilities Bldg., 327 South LaSalle Street.

Paul R. Pollock has been named manager of the Denver, Colo., office of the Allis-Chalmers Mfg. Co., according to a recent announcement.

C. Huizing has been named New England representative for the Watson-Stillman Co. He was formerly in the W-S Sales department as sales engineer and has been with the company five years.

E. T. Cuddeback, who spent nearly five years in the U. S. Army Air Forces and was released as a lieutenant colonel, is now representing the Allis-Chalmers Mfg. Co. out of the firm's Atlanta, Ga., district office.

Obituaries

JAMES DAWES

JAMES H. DAWES, 86, an engineer who constructed waterworks systems, electric plants and railroad facilities throughout the eastern seabord states, died recently at his home in Philadelphia.

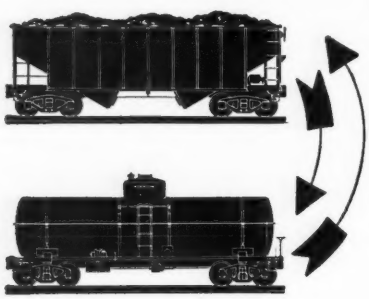
In 1898, Mr. Dawes joined the American Pipe Manufacturing and Construction Co. of Philadelphia as general superintendent of construction. During many years with this firm he had charge of building electric generating plants, water works systems, railroad facilities and general contracting. Mr. Dawes retired from engineering in 1925.

Surviving Mr. Dawes are his wife, and two children by his first marriage, Dorothy Dowling Dawes, of Philadelphia, and Captain James J. Dawes, Jr., of the United States Corps of Engineers.

ARVID PETERSON

ARVID PETERSON, Chief Engineer of the Centrifugal Pump and Compressor Department of the De Laval Steam Turbine Co., Trenton, New Jersey, for 20 years died recently after a short illness. He was born in Spaneholm, Sweden, and came to this country in 1905 and entered the employ of the De Laval Steam Turbine Co. in 1907 to become later one of the leading technicians in his field.

Mr. Peterson was a graduate of the Royal Polytechnic University of Sweden. He held membership in the American Society of Mechanical Engineers, Propeller Club, American Society of Naval Engineers, Society of Naval Architects and Marine Engineers, American Society of Swedish Engineers, Navy League. He was a charter member of the Engineers Club of Trenton and a member of the Board of Directors at De Laval. He formerly was president of the Trenton Country Club.



changing fuels IN YOUR POWER PLANT?

It's No Problem to users of ENCO OIL BURNERS with COAL FIRED UNITS

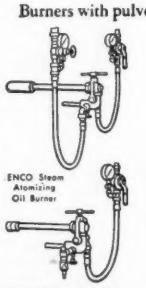
Coal—oil—or both if necessary; changing fuels is no problem if your power plant is equipped with ENCO Oil Burners in combination with coal burning units. Your operations need only be governed by availability of fuels and comparative BTU costs.

ENCO Burners, designed for use with or without air registers and for natural or forced draft, are made in various sizes with capacities from 10 to 1,000 gallons per hour. Mechanical and steam atomizers may be used interchangeably to provide a wide load range from cold starting to full load operation.

With Pulverized Coal Burners either ENCO Mechanical or Steam Atomizers are used for ignition and entire load range. Bulletin OB-PC, giving complete details on use of ENCO Oil Burners with pulverized coal will be sent on request.

from coal to oil and back to coal if necessary!

With Stoker or Hand-Fired Units, this same combination of oil burners with coal fired units can be used with either Steam or Mechanical Atomizer for partial or full loads. Complete information on either temporary or permanent installations of this type will be sent on request.



ENCO Steam Atomizing Oil Burner

ENCO Standard (Mechanical Atomizing) Oil Burner

THE ENGINEER COMPANY
Also Produces
Enco Streamline Baffles
Enco Oil and Gas Burning Equipment
Enco Fuel Oil Pumping and Heating Units
Enco Automatic Combustion Control

THE ENGINEER COMPANY
75 West Street, New York 6, N. Y.
Canadian Representative
F. J. Raskin Ltd., 370 Rachel E., Montreal, P. Q.

MANUFACTURERS' News

LADISH CHANGES NAME

IN A MOVE intended to better reflect the expanded scope of the Company's activities, Ladish Drop Forge Co. of Cudahy, Wisconsin, has announced that the corporate name has been changed to Ladish Co.

It has been felt for some time that the inclusion of the specialized term "drop forge" in the company name may have implied a limitation of products to many industries and business people, particularly users of one of the Ladish major product lines, namely, forged and seamless welding pipe fittings.

NEW CHICAGO BRANCH MGR. FOR FAIRBANKS, MORSE & CO.

FAIRBANKS, MORSE & Co., Chicago, has announced the appointment of John S. King as Manager of its Chicago Branch House succeeding Frank V. Roy who retires from that position on March 1st, 1947.

Mr. King started with the company as a student in the Beloit Plant where he assembled and tested pumping equipment and Diesel engines. In 1921 he was transferred to the Indianapolis Works of the Company, building electric motors and generators. A year later he joined the sales force of the Chicago Branch, working as territorial representative on pumping equipment until, in 1930, he was made Manager of the Pump Department of that Branch. In 1937 he was appointed Manager of the firm's New Orleans Branch.

B & W TO EXPAND RESEARCH PROGRAM AT ALLIANCE PLANT

THE BABCOCK & WILCOX Co. announced recently a program of expanded research in a building on a 20-acre site purchased by it near Alliance, Ohio. It was stated that all the research activities of The Babcock & Wilcox Co. now carried on at its plants, eventually will be centered in the new research development.

With the building, The Babcock & Wilcox Co. has purchased 20.28 acres of land. The Company's research program is under the

More than a Century ... and valves only

OF MAKING VALVES

More than 100 years ago the Wm. Powell Company dedicated itself to the making of valves—*and valves only*. Thus Powell pioneered in the field of specialization long before the "age of specialization" arrived.

The soundness of this policy, backed by continual scientific advancement and the ability to meet every new demand as it has arisen, is attested by the high quality of Powell Valves today.

The Powell Line is so complete that there's a Powell Valve—*in Bronze, Iron, Steel, Pure Metals* or *Special Alloys*—to satisfy every known flow control requirement in every branch of modern industry.

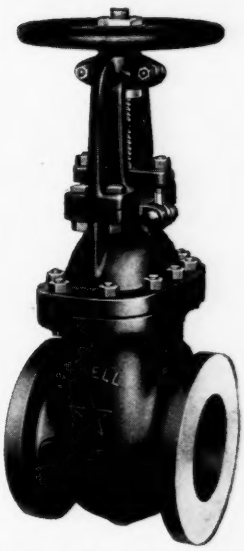


Fig. 1793 — 125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available in All Iron.

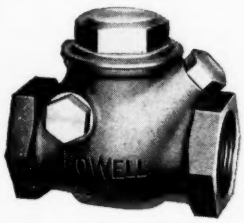


Fig. 560 — 200-pound Bronze Regrinding Horizontal Swing Check Valve. Screwed ends, screwed-on cap and regrindable, renewable bronze disc.

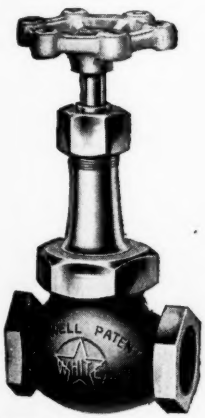


Fig. 1708—200-pound Bronze Globe Valve. Has screwed ends, union bonnet, renewable, specially heat-treated stainless steel seat and regrindable, renewable, wear-resisting "Powellium" nickel-bronze, plug type disc.,

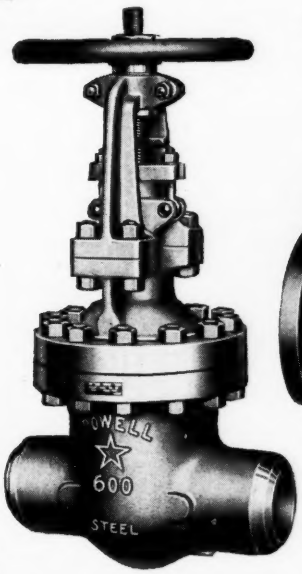


Fig. 6003 W. E. — Class 600-pound Cast Steel Gate Valve with welding ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc.

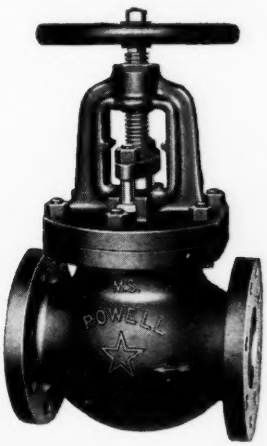


Fig. 301—125-pound Iron Body Bronze Mounted Globe Valve. Has flanged ends, outside screw stem, bolted flanged yoke, renewable bronze seat and renewable composition disc.

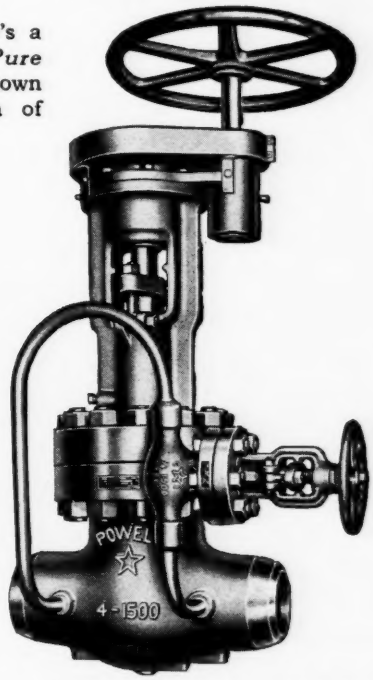


Fig. 1331 W. E.—Class 1500-pound Cast Steel Globe Valve with welding ends and welded by-pass. Spur gear operated.

The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

direction of Leslie S. Wilcoxson, Vice President in charge of research and development.

The building purchased is in the township of Lexington, Ohio. It is one-story, 140 by 300 ft, with mezzanine and basement, and contains 45,000 sq ft of space. The Buffalo Weaving and Belting Co., former owners, acquired the property from the War Assets Administration.

CARBORUNDUM'S PERSONNEL CHANGES

THE CARBORUNDUM CO. announces the following changes in its Refractories Division's sales organization effective January 1, 1947.

Robert A. Barr, formerly District Sales Manager of the Chicago territory, has been named Assistant Sales Manager. He will assume direct control of the Division's field sales force and will eventually make his headquarters at Perth Amboy, N.J.

Selected as Technical Assistant Sales Manager, Arthur A. Turner will be in charge of the Sales Development Department whose function is to accelerate the development, production and marketing of the Division's new products and to supervise field operations of the sales force as assigned. Mr. Turner will maintain his office at Perth Amboy, N.J.

Richard D. Rudd, a ceramic engineer by training and previously connected with the Certain-Teed Products Corp. in a sales capacity, will serve as Refractories Engineer in the Chicago territory succeeding Mr. Barr.

D. Worth Polhemus has been transferred from the Cincinnati to the Philadelphia district, succeeding J. G. Fritzinger, who has been appointed District Sales Manager for the Abrasive Division in the Philadelphia district.

J. H. Wisby will take over the Cincinnati territory as Refractories Engineer. Mr. Wisby will make his headquarters at the company's Cincinnati branch office.

G.E.'S PLASTICS DIVISION SPLIT

ORGANIZATION changes in the General Electric Chemical Department establishing the plastics division and the compound division in place of the former plastics divisions were announced today by Dr. Zay Jeffries, vice president and general manager of the department. Simultaneously, Dr. Jeffries announced the appointments of George P. Lehmann as manager of the plastics division and John L. McMurphy as manager of the compound division. Both men will make their headquarters in Pittsfield.

HALLSTEIN NEW V.P. OF AUSTIN CO.

ELECTION of Harold A. Hallstein to the newly created post of Executive Vice President of The Austin Co., Engineers and Builders, was announced recently following the organization meeting of the board of directors. Shareholders, at their annual meeting, increased membership on the board from seven to nine, electing Laurence E. Cooney, vice president and general manager of sales, and Harold A. Anderson, vice president and eastern district manager, to these directorships.

The volume of business contracted for and built in 1946 was 4½ times the largest prewar billing in the company's history. He said a substantial amount of work is being carried forward into 1947 and that total volume for the year should more than equal that of 1946. Contracts in effect cover a wide range of industries located in all parts of the country. In addition to the active projects, he reported that a number of industries are showing increased interest in the opportunities to reduce production and distribution cost by construction of new plants.

BURNDY OPENS NEW WEST COAST PLANT

TO PROVIDE service for the increasing number of electrical connector users in the western states, the Burndy Engineering Co. has opened a new factory and warehouse in Vernon, Calif.

The new plant will manufacture many of the connector types which are also produced at the company's main factory in New York City. Substantial stocks will be maintained on all of the more commonly used connectors.

Facilities have been provided to produce connectors on short notice in cases of emergency. The Vernon plant operates under the supervision of Lawrence Lyons, formerly a member of the field engineering staff of the Company.

BOYLE NEW V.P. OF BALDWIN LOCOMOTIVE

W. F. BOYLE, who has been General Manager of the Pelton Water Wheel Company, a subsidiary of The Baldwin Locomotive Works, has been named Vice President of that company according to a recent announcement. The plant and offices of the Pelton Water Wheel Company are in San Francisco and Mr. Boyle has been Baldwin's Pacific Coast District Sales Manager as well as General Manager of Pelton.

JUHNKE OF C.E. RETIRES

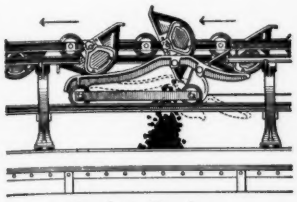
PAUL B. JUHNKE, veteran chief operating engineer of Commonwealth Edison Co., Chicago, retired from active duty January 1 after 43 years of service.

Nearly 270 of his associates gathered at a farewell dinner held in his honor at the Union League Club, December 30. Speakers included Charles Y. Freeman, chairman of the utility; Edward J. Doyle, president, and Harry B. Gear, retired vice-president. Alex D. Bailey, vice-president, was toastmaster.

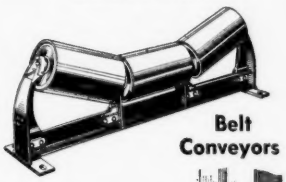
Mr. Juhnke, who during his long Edison career has seen the number of the company's customers grow from 27,000 to nearly a

LINK-BELT EQUIPMENT

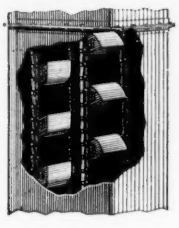
Meets Every Need of Industry in Handling Materials



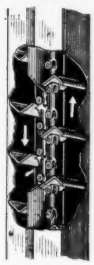
Bucket Carriers



Belt Conveyors



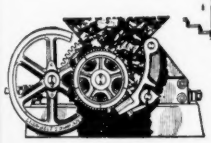
Bucket Elevators



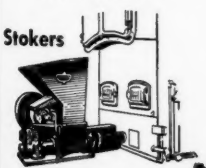
Bulk-Flo

Screw Conveyor

Skip Hoist



Coal Crusher

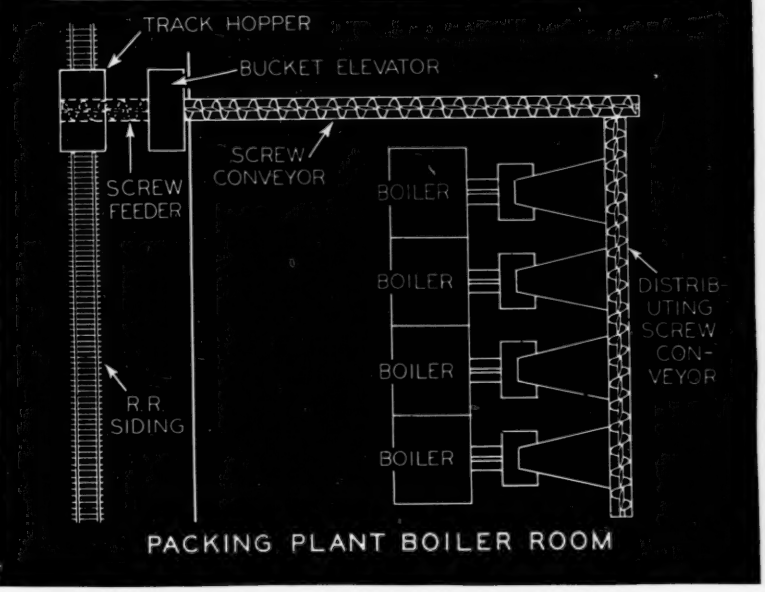


Stokers

Car Dumper

Weigh Larry

CUTTING COSTS WITH CONVEYORS



The Boiler Room Was a "Gold Mine"

NOTE to plant men who need to cut expense corners to combat high material and labor costs: your boiler room may be a "gold mine" for savings.

With the packing plant boiler house coal handling layout shown above, a problem was solved by a combination of Link-Belt units. Through a screw feeder, bucket elevator, screw conveyor and distributing screw conveyor, coal is handled from gondola cars to stoker hoppers. The services of only one man are required for unloading and maintenance. There is no coal dust problem.

The best team efficiency occurs when each man is a star at his own position. On the Link-Belt conveyor team are stars for any conveyor function, with a top-flight coach (the Link-Belt engineering department), to coordinate the overall result. Link-Belt makes Screw Conveyors . . . Bulk-Flo Elevator-Conveyors . . . Overhead Trolley Conveyors . . . Bucket Elevators . . . Skip Hoists . . . Belt Conveyors . . . The Sidekar-Karrier . . . Apron Conveyors . . . The Peck Carrier . . . Flight Conveyors . . . and many others.

Let us develop an efficient low-cost solution to your coal handling problem.

LINK-BELT COMPANY 10,547

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

LINK-BELT

COAL AND ASHES HANDLING EQUIPMENT

million, started in 1903 as an electrician's helper in the construction department, later served as an oil switch repairman and construction foreman and transferred to the load dispatchers office in 1905. He was promoted to chief load dispatcher in 1912, assistant chief operating engineer in 1942 and chief operating engineer the following year.

Born in West Prussia, Germany, in 1879, the year Thomas Edison invented the incandescent lamp, Mr. Juhnke came to Chicago with his family at the age of 12. He was graduated from Lewis institute with an electrical engineering degree in 1903 and served as president of Lewis Union, the school's alumni association, in 1924-25. A past chairman of the Chicago section of the American Institute of Electrical Engineers, he is also a fellow and a former director of the organization and was at one time chairman of the electrical section of the Western Society of Engineers.

(Continued on Page 180)

HELPFUL BULLETINS

(Continued from Page 52)

43 Diaphragm Control Valves—A new series of diaphragm control valves—Series 700—are described in this new bulletin No. 500, 24 pages. Outstanding features of the valve, its Neoprene diaphragm, pivoted inner plate, elastic spring flange, etc., are discussed briefly in the first page of the Bulletin. Completely illustrated, the catalog pictures the minutest details of the valves' construction and charts and tablescover specifications and characteristics of the valves. Several pages of dimensioned drawings and tables of dimensions are given. H. Belfield Company.

44 Stainless Steel Welding Fittings—Eleven types of stainless steel fittings and 8 types of stainless flanges are covered in this 24-page bulletin. A double-page spread pictures and names the types of fittings and flanges, the next two pages shows prices for the various weights of fittings. Dimensional tolerances, general characteristics and specific characteristics are also covered. Tables of allowable pressure-temperature ratings for standard weight and also for extra strong fittings are given and a third full-page table covers internal pressure stress and expansion stress ranges. Welding procedure and corrosion resistance data tables add to the book's usefulness. Tube Turns, Inc.

MAINTENANCE

45 Protective Coating for Severe Corrosion—The outstanding features of this protective coating (Ucilon) in paper making, chemical industries, oil refineries, food industries, maritime service and public works or wherever severe corrosive conditions exist are outlined in this new bulletin. It points out how the coating may be applied by brushing, spraying or dipping to metal, wood or concrete. It is reported to protect surfaces of these materials against acids, alkalies, alcohols, salts, oxidants, cleaners, sewage water, oils, gasoline, foods and beverages. The preparation, application, coverage and drying of the material is sketched and a listing of the various types of coating materials is given. United Chromium, Inc.

46 Repairs Handbook—Here is a 40-page handbook crammed with information on all types of repair procedures for every conceivable piece of equipment and location. Made doubly useful through the skillful use of line drawings the booklet covers the following subjects, to name a few: anchoring bolts and screws, auto engine repairs, auto radiator leaks, oil-proofing concrete, cracked pipes, leaks in heater joints, water jacket cracks, welding, manifold connections, fire pot cracks, roof leaks, and many, many others. Smooth-On Mfg. Co.

47 Floor Resurfacing—This recently-published folder describes the methods of use of the company's heavy-duty resurfacer for use on floors, traffic aisles and loading platforms. It contains a concise, clear description of the properties, methods of application and advantages of the resurfacer and is of interest to everyone who has problems in the maintenance and repair of concrete floors. Stonhard Company.

48 Packing Installation and Maintenance Manual—This new 32-page manual contains complete information on the company's metallic packing and proved methods of application, operation and maintenance. The bulletin starts out with illustrations of standard piston rod and valve stem assemblies which are accompanied by parts lists, names of packing and materials. Other illustrations of this type are Tandem style rod packing assembly, steam pipe slip joint assembly, standard air pump packing assembly, etc. The second section of the booklet covers instructions for application, maintenance and operation of metallic rod packing; this includes causes of packing difficulty and recommendations for overcoming them . . . Improper installation and maintenance of packing parts and a simple method for applying supplemental springs. The back section of the book gives directions for ordering metallic rod packing (this section includes tables on sizes, lengths and weights of packing segments). Installation diagrams are covered in 6 pages and are provided for convenience in ordering replacement parts. Paxton-Mitchell Co.

MISCELLANEOUS

49 Construction Data Handbook—This new edition of the Horn Construction Data and Handbook has just been announced. The first section of the handbook gives compact technical data on all the company's products such as waterproofings, damp-proofings, roofing materials, exterior and interior coatings, flooring materials, etc. The second section of the handbook is a veritable treasury of useful tables, conversion factors, estimating tables, weights and strengths of building materials and so forth. A. C. Horn Co., Inc.

50 Fire Extinguisher Slide Rule—This new selector guide answers vital questions about fire extinguishers. The company points out that it condenses 222 fire facts in a handy vest-pocket size. Typical of some of the questions answered by the guide are "What is the range of a 5 gallon pump tank fire extinguishers?" "Will our soda-acid extinguishers freeze in low temperature?" "How do you operate a dry powder extinguisher?" This compact data guide presents important facts about the suitability, maintenance and performance of several types. The reverse side of the guide, tells in relation to your plant fire hazards, how high unit should be bracketed, maximum distances of the extinguishers from the operator and the area protected by each unit. Randolph Laboratories, Inc.

RODA

High grade gas, by-product and steam coal from Wise County, Va., on the Interstate Railroad.

DENDRON

High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA

High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

PREMIX STOKER

A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

COKE

Roda and Stonega from Wise County, Va., and Connellsville Coke from Pennsylvania.

CRITERION COAL

High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

CROZER

Genuine Third Vein Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railroad.

LYNCO

Medium volatile, high fusion coking coal for by-product and steam use from Wyoming Co., W. Va., on Vgn. Ry.

Old Kentucky

Hazard No. 4 and No. 7 steam and domestic coal from Wiscoal, Knott County, Kentucky, on the L. & N. Railroad.

CHARMCO

Unexcelled Steaming Coal from the Fire Creek Seam in Greenbrier County, W. Va., originating on the N. F. & G. R. R.

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In Power Plant Flues

ECONOMICAL LUMNITE LININGS RETARD CORROSION AND ABRASION

Flues between boilers and stacks at a large eastern power plant had been subjected to the corrosive attack of acid condensate. Scouring action of the cinder-bearing gas had worn away the corroded metal. In sections where condensation was heaviest—outside the building—the flues had become almost paper thin. The problem was to repair these flues and to protect them from corrosion and abrasion. And the method had to be quick and economical.

The damaged flues at this station were repaired by installing a 1½-inch-thick lining of corrosion-resistant concrete made with LUMNITE cement. The lining was reinforced with wire fabric attached to lugs welded to the shell. Patch plates were welded on the outside surface over holes and thin spots. The concrete, placed with a cement gun, was tightly bonded to the steel shell.

This repair procedure saved the labor and expense of rebuilding the flues. The protective LUMNITE lining has prevented further deterioration. The insulating effect of the lining is an added advantage, as paint lasts longer on the cooler outside surface. Also, the lining stiffens the flues and eliminates vibration.

The advantages LUMNITE gave this flue repair job are applicable to many other power plant installations. For further information about this installation, and other power plant uses of LUMNITE, write to:

Lumnite Division

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS

51 **Steam Generators**—Catalog almost completely devoted to cross-sectional drawings with accompanying listing of principal data of typical installations in rubber companies, steel works, sugar refineries, municipal plants, etc. Details of furnace water wall construction on inside back cover; 16 pages. Henry Vogt Machine Co., Inc.

52 **Double-Pass Boilers**—Bulletin RM-1 (6th) edition); illustrates and describes this line of riveted or welded double-pass steel firebox boilers. Three full pages of dimensions, ratings and other details including dimensioned line diagrams; 8 pages. The Brownell Co.

53 **Boilers, Burners, Accessories**—Bulletin GC-10; condensed catalog of regular products for stationary power plants. Each class of equipment summarized and illustrated. Well illustrated with line drawings and photographs. Illustrations accompanied by brief descriptions; 12 pages. Combustion Engineering Co., Inc.

54 **Standardized Boilers**—Bulletin 746; 4 page bulletin presenting construction and operation information and ordering specifications for this company's Type M boilers. Bulletin illustrated, presents table of measurement and data. Springfield Boiler Co.

55 **Steam Generator**—Bulletin 119; company's Type S steam generator described and features of construction are pointed out. Folder well illustrated and dimensioned drawing and table of dimensions and sizes given. Union Iron Works.

PRIME MOVERS

56 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. Terry Steam Turbine Co.

57 **Multi-Stage Turbine**—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

58 **Steam Engines**—Bulletin No. 306; Engineering data; tabular material, descriptions; 8 pages. Troy Engine & Machine Co.

59 **Generating Sets**—Bulletin No. 108; General descriptions, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

60 **Stationary Diesel Engines**—Dependability, adaptability of Diesel power described and the first five applications pointed out. Its economical and simple design is stressed. Advantages of company's equipment brought out; exceptionally well illustrated; 24 pages. Enterprise Engine and Foundry Co.

AUXILIARIES, ACCESSORIES

61 **Strainers and Separators**—Bulletin 46-50; describes complete line of company's strainers and separators. Dimensions and price lists, dimensioned drawings and photographs; tables of sizes and complete description of applications, operation and design; 16 pages. American District Steam Co.

62 **Atomizing Deaerators**—Bulletin 4160; 3 color drawing illustrates description of principle of operation. Advantages of deaerators are described and illustrated; marine deaerators also covered; 20 pages. Cochrane Corp.

63 **Steam Condensers**—Bulletin 1461 "Steam Condensers"; exceptionally well illustrated with line drawings, charts and photographs. Large proportion of the catalog devoted to engineering information such as calculations of required surface, atmospheric relief valve sizes, tube characteristics, free dry air leakage, pressure-temperature conversion tables and tables of logarithms; 46 pages. C. H. Wheeler Mfg. Co.

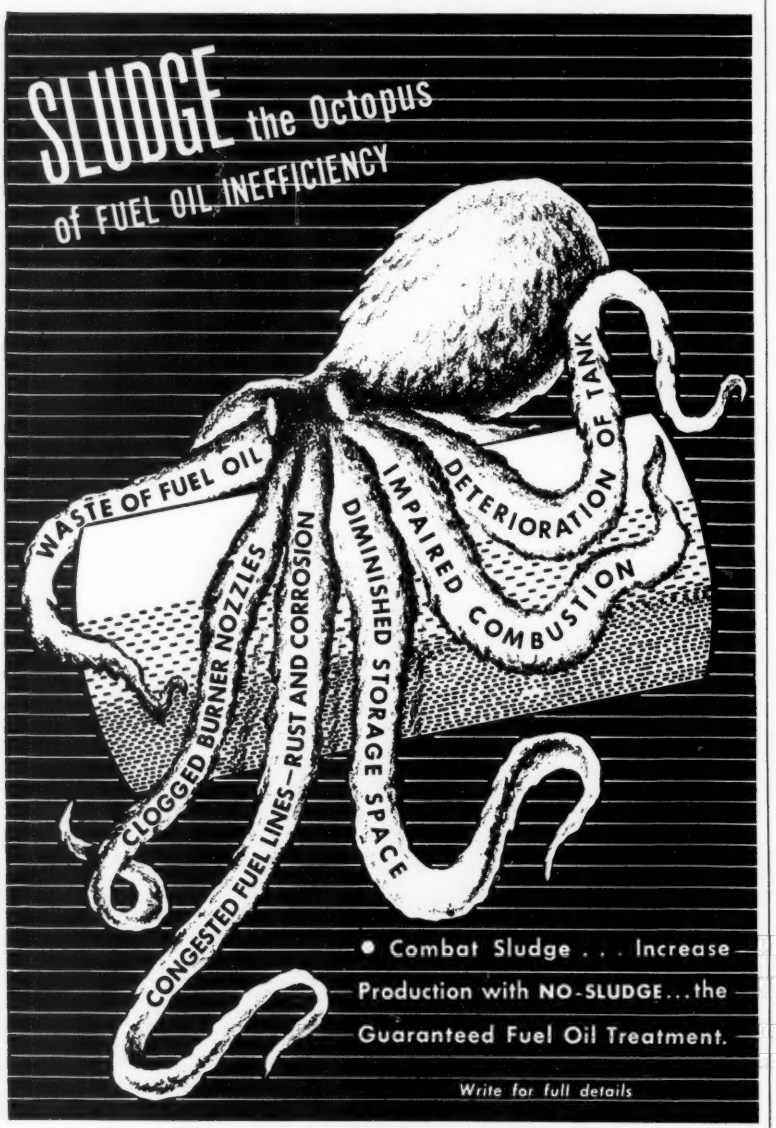
64 **Condensate Return System**—Description of operation and possible savings accompanied by line diagram and description of how "Jet-Loop" works; typical installations pictured and described. Drawings and text shows proven results from experience of users. 2 page spread of drawings and table of dimensions; 16 pages. Cochrane Corp.

65 **Low Pressure Evaporators**—Description of L. P. evaporators; types of evaporator plants, listing of advantages of L. P. submerged tube evaporators. Line diagrams illustrate principles brought out in descriptions. Typical installations are considered and analyzed; 12 pages. Condenser Service and Engineering Co., Inc.

66 **Power and Industrial Equipment**—Bulletin Q-12; describes and illustrates company's equipment for power and industrial use—steam turbines, motors, generators, feedwater heaters, turbo-chargers, steam jet ejectors, centrifugal blowers. Exceptionally well illustrated; 20 pages. Elliott Co.

67 **Heat Exchanger**—This new bulletin describes the company's Twin G-Fin Section; Bulletin 1614; section characterized as universal heat exchanger. Bulletin tabulates 21 features and corresponding advantages, describes design and construction. Installation views shown, field reports included; 16 pages. The Griscom-Russell Co.

68 **Evaporators**—Bulletin 364 describes, illustrates evaporators for various capacities and pressures; contains sections of special interest to plant engineers and executives; includes explanation of functions of evaporators, benefits obtained



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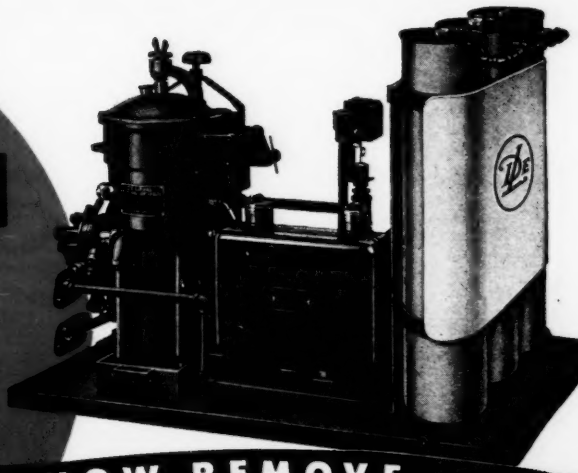

YOU CAN NOW REMOVE
DIRT-CARBON-WATER
FROM DIESEL LUBE OIL!

Note these Features

1. Removes dirt and water by centrifugal force
2. Filters out harmful carbon
3. Does not remove valuable additives
4. Cleans oil at moderate temperature
5. Speeds up inspection—crankcase is cleaner
6. Minimizes ring sticking
7. Increases bearing life
8. Saves labor—long runs without bowl cleaning
9. Increases oil life
10. No dirt . . . carbon . . . or water

THE De Laval "Puri-Filter" enables the Diesel operator to purify Diesel lubricating oil by a combination of centrifugal force and positive filtration. It combines the De Laval "Uni-Matic" Oil Purifier which centrifugally removes most solid impurities and all water, and Fram "Filcron" Filters which, in cleaning the Diesel lubricating oil, also restore the oil to a translucent amber color. The De Laval "Puri-Filter" leaves the lubricating oil ***clean*** and ***dry*** . . . provides the ***maximum*** in protection for every engine.

The De Laval "Puri-Filter" is complete with dirty-oil and clean-oil pumps, and is piped, ready to operate. Electrical controls are provided and all parts are mounted on a metal base.

For additional details, ask for Bulletin DL-1.

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DE LAVAL OIL PURIFIERS FOR DIESEL LUBRICATING OIL

by their use; different types of evaporator systems and their association with plant heat balance. 26 pages. The Griscom-Russell Co.

69 **Soot Blowers**—Bulletin F45; soot blowers in general are described. Description and operation of units, materials and specifications and other pertinent information is presented; tables of steam consumption, boiler efficiency, fuel saving chart; boiler cross-sections with blower locations indicated thereon and installation drawings and data are included; 30 pages. Marion Machine, Foundry & Supply Co.

70 **Water Heater Capacity Ratings**—14 tables are included in this ratings booklet showing capacity ratings per hour for temperature rises of from 20 deg (50 to 70 deg) up to and including ratings for a 150 F temperature rise (50 to 200 F). Table No. 15 presents the rate of flow of steam through pipes with steam from an initial gage pressure of one pound up to 150 psi. Marion Machine, Foundry and Supply Co.

71 **Fin Coils for Cooling**—Bulletin 120; directions for ordering fin coils, description of coil features, tables of dimensions, ratings, shipping weights, list prices of ceiling coils, storage coils, etc. Baffling, overhead blower units, custom built air conditioning coils and other equipment described and illustrated; 20 pages. Rempe Co.

72 **Air Ejectors**—Bulletin M-300 and M-301; what they do; types, blueprint type drawings, tables of sizes, manufacturing facilities and equipment; total 16 pages. The Lummus Co.

73 **Coal Weighing Scales**—Description; outstanding features, specifications, line drawings, photos; 4 pages. Beaumont Birch Co.

74 **Rack and Pinion Gates for Coal and Ashes**—Ball-Bearing, dust-tight features; photos, specifications, drawings, tables of dimensions; 4 pages. Beaumont Birch Co.

75 **Steam Specialties**—Collection of folders; steam trap, air trap, reducing valves, classes E. B and H pump governors, automatic boiler feedwater controller; parts and unit list prices; descriptions; illustrations; tables of capacities. The C. E. Squires Co.

76 **Deaeration**—Data book; No. N-15 gives reasons for and principles of deaeration; cold water deaeration; tabular drawing and chart material presented; well illustrated; 20 pages. Elliott Company.

77 **Power Plant, Industrial Process Equipment**—Steam turbines, turbine generators, mechanical drive turbines; motors and generators; feed-water heaters and deaerators; condensers and auxiliaries; steam jet ejectors; centrifugal blowers; turbochargers for diesels; accessories and tube cleaners; completely illustrated; 20 pages. Elliott Company.

78 **How to Choose a Steam Trap**—Trap selection, trap rating, trap capacity factors, individual trapping, determining lift; traps for unit heaters, pipe coils, fan system heating surfaces, steam jacketed kettles, autoclaves, laundry equipment, paper makers, etc.; installation, operation, maintenance, instructions; specifications and capacities; corrosive service; 42 pages. The V. D. Anderson Co.

WATER TREATMENT

79 **Index for Calcium Carbonate**—Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

80 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

81 **Water Treatment**—Scale and corrosion control in potable water supply; reprinted paper presented by Hanlon, Steffen, Rohlich and Kessler; 12 pages. National Aluminate Corp.

82 **Water Conditioning Service**—"The 6 Fundamentals of Betz Water Conditioning Service" illustrates and describes how this company extends a supervisory service for boiler water conditioning. Booklet shows complete operation of these 6 steps; 16 pages. W. H. & L. D. Betz.

83 **Water Softeners**—Bulletin 607; benefits and economies of soft water; typical applications; how it works; types; design and features; backwash and brine rinse regulators; how to modernize present softener; aerators, degasitors, chemical feed systems, chemicals; 20 pages. Elgin Softener Corp.

84 **Softener Handbook**—Manual, semi- and full-automatic zeolite water softeners are covered in Bulletin 315. Water softener plant is discussed in the first section and operating cycles and and plant supervision is next considered. The third section is "Selecting Manual or Automatic Equipment"; this is accompanied by a table of comparison data. There also is a two-page section of tabular material and a zeolite nomographic chart. Graver Tank & Mfg. Co., Inc.

85 **Sludge Reactivator**—Illustrated booklet, 8 pages, fully explains the principle of upward sludge filtration and describes its adaptability to industrial and municipal water supplies. Charts, flow diagrams and cut-away drawings show clearly how equipment softens and clarifies raw water, materially reduces reaction time and provides, in many cases, a water that is suitable for process work without further treatment. Graver Tank & Mfg. Co., Inc.

86 **Hot Process Water Treatment**—Form 326 is a case study bulletin; covers results of an installation of the company's hot process equipment at Kankakee Ordnance Plant. System was designed to provide 60,000 gph of properly conditioned water, free from hardness, scale forming minerals and corrosive gases. Excellent photos and schematic diagram of installation with flow of water indicated. Graver Tank & Mfg Co., Inc.

87 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Products, Inc.

88 **Industrial Water Treatment**—Micro-biological Control of and Through Industrial Waters; spot summaries of improvement of process efficiency and product quality by proper sterilization. Wallace & Tiernan Products, Inc.

89 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important considerations in chemical treatment of cooling water circuits. Wallace & Tiernan Products, Inc.

90 **Water Treatment**—Chlorine Destroys Ammonia, by A. E. Griffin. Gives data on use of chlorine for elimination of ammonia from boiler feed water. Wallace & Tiernan Products, Inc.

91 **Clarifying and Softening Water**—Eight-page catalog "Reactivator for Clarifying and Softening Water by Upward Sludge Filtration." First part of the booklet tells how the reactivator works and how the sludge blanket is kept in control so as not to flow out with the clarified water. Line diagrams illustrate the principle of operation.

20 YEARS AGO
taking the curves was a real problem

Twenty years ago, taking curves smoothly—without loss of cleaning efficiency—was a real task for a tube cleaner. Ponderous knocker and cutter heads slowed down the motors—sometimes caused them to stall.

Today, negotiating the short radius curves in marine and power plant tubing presents no problem. Up-to-date Wilson ECT Series Air Motors in combination with patented Wilson Expanding Brushes make short work of removing any deposit in boilers operated under modern methods.

Through the years Wilson engineers have kept pace with improvements in boiler design. In developing the ECT Motor, they solved the problem of sacrificing power for small diameter by combining small size with *even greater* power!

Size-for-size this compact, powerful motor often develops up to 40% more power while "taking the curves" . . . cleaning tubes faster, more thoroughly, and more economically as it goes!

The six-bladed, light-bladed construction of the ECT Series Air Motor provides higher torque, a smoother flow of power, at any speed . . . 12 powerful impulses per revolution. Its automatic valving of operating air means less air consumption . . . a minimum of back pressure. And this motor is easy to start, hard to stall because six blades eliminate the dead center!

You'll find that faster tube cleaning—made possible by the extra power in the Wilson ECT Series Air Motor—means less downtime—lower production costs for you. Write today for additional information and the name of your nearest Wilson representative. Please address Department N.

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WILSON
TUBE CLEANERS

TW-710

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WHY the Foster 38-SV Safety Valve is ESPECIALLY SUITABLE FOR

HIGH PRESSURES HIGH TEMPERATURES

Pressures up to 3000 pounds and temperatures of 1200° F. are easily handled by the Foster Type 38-SV Super-Jet Safety Valve—it was designed especially for just these exacting requirements! It's no mere "beefed-up" low-pressure valve—rather it's a basic new design for high-pressure service.

Only the Foster 38-SV Safety Valve gives you all these advantages:

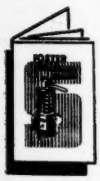
1 . . . ***Exceptional steam economy*** because . . . it reseats as low as 1% below popping pressure . . . reseating is positive; without pounding or chatter . . . blowdown is adjustable from 8% down to 1%.

2 . . . ***Unaffected by temperature changes*** because . . . frame rod construction makes crawl negligible . . . deflector protects spring and rods from escaping steam.

3 . . . ***Maximum protection*** because . . . full opening is practically instantaneous . . . full rated nozzle capacity is available at popping pressure . . . once set under operating conditions, its popping point is constant.

4 . . . ***Positive reseating*** because . . . floating disc design . . . steam-centered piston . . . permanently flat seats.

Specify the Foster 38-SV Super-Jet Safety Valve for the finest in high-pressure protection!



Complete details of the Foster 38-SV Super-Jet Safety Valve, for pressures up to 3000 pounds and temperatures up to 1200° F., are given in Bulletin 25. Write for it today!

FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . AUTOMATIC STOP AND CHECK VALVES . . . ALTITUDE VALVES . . . DAMPER REGULATORS . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . LIQUID LEVEL CONTROLLERS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN AND TRIPLE DUTY VALVES . . . VACUUM REGULATORS OR BREAKERS . . . SIGHT FLOW BOXES . . . STRAINERS . . . SAFETY VALVES . . . SIRENS

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Two pages are devoted to a sectional diagram through a reactivator and the accompanying copy tells about the unit's features. Actual installations are pictured and described. Graver Tank & Mfg. Co., Inc.

92 **Feed Water Treatment**—This four-page folder tells how the company's engineering applied to boiler feed water problems can result in savings. It tells of the different procedures and presents diagrams of equipment arrangement. Typical installations in dairy, cosmetic, aircraft, laundry, and other plants are pictured. Illinois Water Treatment Co.

94 **Chemical Feeding and Proportioning**—Bulletins 1100 and 1713A; use of adjustable chemical feeder for water treating, sewage, chemical processes, petroleum; plan and sectional diagrams; descriptions; photos; general specifications; 2-page table of capacity schedules; list of chemicals handled; accessories; drawings of boiler water conditioning systems; 5-page description of method of automatic intermittent feed of conditioning chemicals direct to the boilers; 20 pages. Proportioneers, Inc.

95 **Automatic Proportioning**—Bulletin 1200, 28 pages. Handy reference book containing wealth of information on automatic flow responsive equipment and methods in continuous process operation. Photos of equipment and installations are supplemented by many flow diagrams and detail drawings. Complicated subject made exceptionally clear and understandable by careful arrangement and two-color diagrams. Proportioneers, Inc.

96 **Chemical Proportioning Equipment**—Bulletin 1714 covers chemical proportioning equipment for sea-going service. Two units—for high or low pressure—are described fully. Tabular material assists in the description. Proportioneers, Inc.

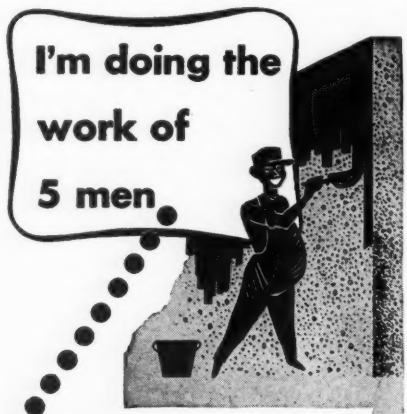
COATINGS, TREATMENT

97 **Protective Coatings**—4-page folder 844-246 describes Bitumastic Hi-Heat Gray, a specialized industrial protective coating which is said to resist corrosion and temperature up to 1200 F. The folder is in 2 colors and contains several photographs of equipment on which Bitumastic has been applied. It also gives a list of uses for the material and a chart giving its characteristics. The last page of the folder contains a brief description of four other types of Bitumastic coatings. Wailes Dove-Hermiston Corp.

98 **Fuel Oil Treatment**—A 4-page bulletin, telling about the company's treatment for fuel oil called "No Sludge." Advantages of using the treatment such as stepping up efficiency and reducing operating costs are explained. A list of dosages and applications are also given. A free test offer of the treatment is explained on the first page of the bulletin. Dominion Chemical Co., Inc.

99 **Flue Cleaner**—The company's soot and fire scale removing compound is described in this six-page folder. Results obtained from the use of this compound are described in the first part of the folder and then a list of the things which the company guarantees the material will accomplish are listed. Tables of dosage are presented and another table shows losses due to soot and fire scale. Dominion Chemical Co.

100 **Boiler Rust Treatment**—This four-page bulletin describes the company's "Rustoff" chemical which is said to "build resistance to rust and scale corroded and congested pipes." The bulletin tells haw the treatment works and what results may be expected from its use. A brief description of the campany's service department is included. Dominion Chemical Co., Inc.



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HEATING, COOLING

101 **Cooling, Heating, Air Conditioning**—Collection of bulletins; installation, design, construction data, capacity ranges, condensed physical data; numerous photos of installations, full page color diagrams of flow of air, compressed air, water, water spray, etc.; 74 pages. Niagara Blower Co.

INSULATION

102 **Industrial Insulations**—Block, blanket insulations; pipe covering; new pressure coverings; insulating cement; felt; Koldboard; fill insulation; diatomaceous earth products; uses, specifications, applications, preparation; charts; photos; list prices; 26 pages. Baldwin-Hill Co.

103 **Insulating Cement**—Ease of application; efficiency; ease of maintenance; application recommendations; heat loss calculations; 4 pages. Baldwin-Hill Co.

STOKERS

104 **Air-Cooled Stoker**—Catalog R-A; features of construction; how timing device works; installation drawings, ash discharge, air cooling features; features of front end driving mechanism; engineering data tables; 20 tables. American Engineering Co.

105 **Water-Cooled Stoker**—Catalog W; drawings of installations; features; furnace views; 8 pages. American Engineering Co.

106 **Spreader Stoker**—Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

107 **Pneumatic Spreader Stoker**—Three-fold booklet on the inner pages of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

108 **Poweram Stoker**—Bulletin 7121; essentials of successful stoker; fuel control, fuel conveying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

109 **Coal Reference Bulletin**—Bulletin 8, Underfeed Stoker Firing. Bulletin covers factors involved in selection of multiple retort stokers, principles, design data and drawings of typical installations; 6 pages. Fairmont Coal Bureau.

OIL, GAS BURNERS

110 **Oil Burning Systems**—Bulletin 45-1; three types of systems; drawings, tables of capacities and descriptions; photos 4 pages. Faber Engineering Co.

111 **Mechanical Oil Burners**—Bulletin 45-2; two systems; drawings, tables of capacities and descriptions of units; parts list; 4 pages. Faber Engineering Co.

112 **Wide Range Oil Burning System**—Bulletin 109; How the system operates; control; drawings; 4 pages. Peabody Engineering Corp.

113 **Oil Burners**—Bulletin 108; Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

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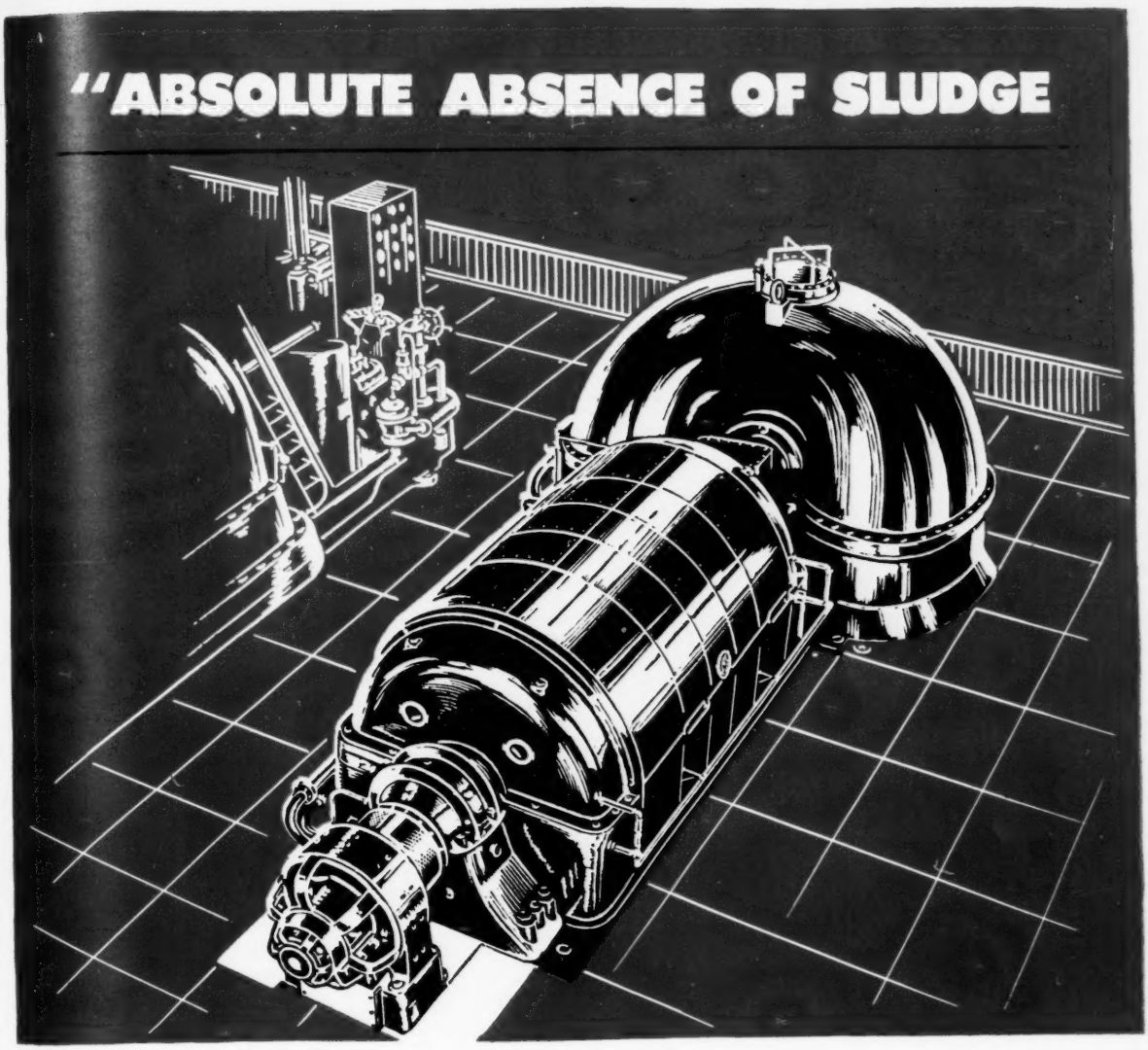

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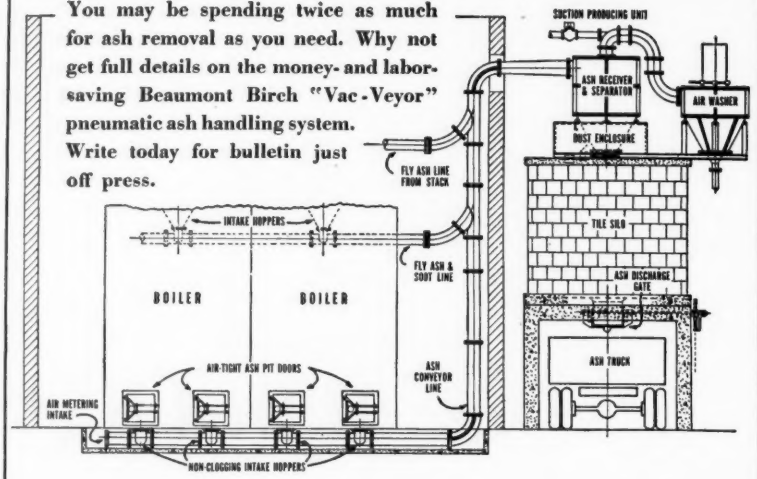

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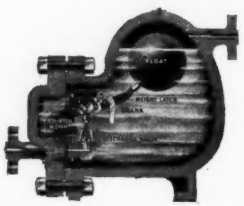

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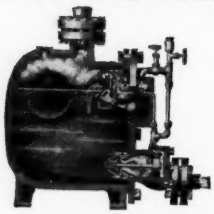

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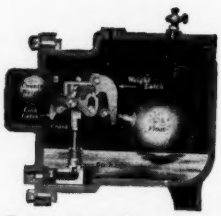

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Top and bottom traps shown are weight-operated; middle, piston-operated. Pressures to 1500 lbs.

114 **Gas Burners**—Bulletin 203; description of A and H gas burners; cross-sectional diagram; photos of atomizers; 4 pages. Peabody Engineering Corp.

OIL, LUBRICATION

115 **Lublication Recommendations** — Special oils for diesels and heavy-duty gasoline engines; facts about oil; tables of recommended oils for various models; 18 pages. Standard Oil Company of California.

116 **Cutting Fluids**—Facts about cutting fluids; machine tool operations; fundamentals of cutting; how to apply; metallic cutting tools; tabular material; show practices; 50 pages. Standard Oil Company of California.

117 **Diesel Operation**—Relation of fuels and lubricants to the operating efficiency in the diesel engine; diesel fundamentals; maintenance; lubrication and fuels; supercharging; selection and classification of fuels; fuel injection maintenance; improving cleanliness; tabular material, charts, formulas; 114 pages. The Texas Co.

118 **Engineers Report on Oil**—Engine tests, laboratory tests, effects on engines, bearing corrosion, actual service data, filter clogging, service experience; well illustrated with photos and charts; 42 pages. Standard Oil Company of California.

119 **Lubricants Service Handbook**—28 pages in this booklet on lubricants and their application. The development of the lubricant, its features and advantages and the manner in which it meets various operating conditions take up the fore part of the booklet. Two pages are used to cover definition of the various types of lubricants in the line, both fluid and grease type. "Application of Lubriplate Lubricants" is a useful section of the book; it shows and tells by sketch and description where the various lubricants should be used and why. The most useful part of the book is the "Recommendations" section where the manufacturer tells just what grease or oil should be used according to speeds, temperatures, pressures and general service conditions. Fiske Brothers Refining Co.

POWER TRANSMISSION

120 **Speed Reduction, Increase Gear**—Bulletin S-130; description; gear cases; gear and pinion; bearing; lubrication; drawings and photos; 8 pages. The Terry Steam Turbine Co.

121 **V-Belt Drive Guide**—Bulletin B6051F; guide to company's complete line of V-belt drives. Contents include types and sizes. V-belt prices, how to figure drives, belt selector charts and tables and similar engineering information. Well illustrated; 12 pages. Allis-Chalmers Mfg. Co.

122 **Chains and Sprockets**—Bulletin D-1; 2 color digest catalog, profusely illustrated, gives pertinent information on drive and conveying chains and sprockets, finished steel roller chains and sprockets, silent chains and sprockets, flexible couplings. Tables of numbers and pitches are given as are full page tables of list prices, dimensions and weights; 16 pages. Union Chain & Mfg. Co.

123 **Flexible Couplings**—Bulletin 57; 2 pages of drawings and tables of ratings for company's flexible couplings. Installations are shown and features of the various types are discussed; 20 pages. John Waldron Corp.

VALVES

124 **Regulating Valves**—Bulletin 1-A; valve data book; description, dimensions and lists of parts; typical installations, rated capacities; prices: 52 pages. Atlas Valve Co.

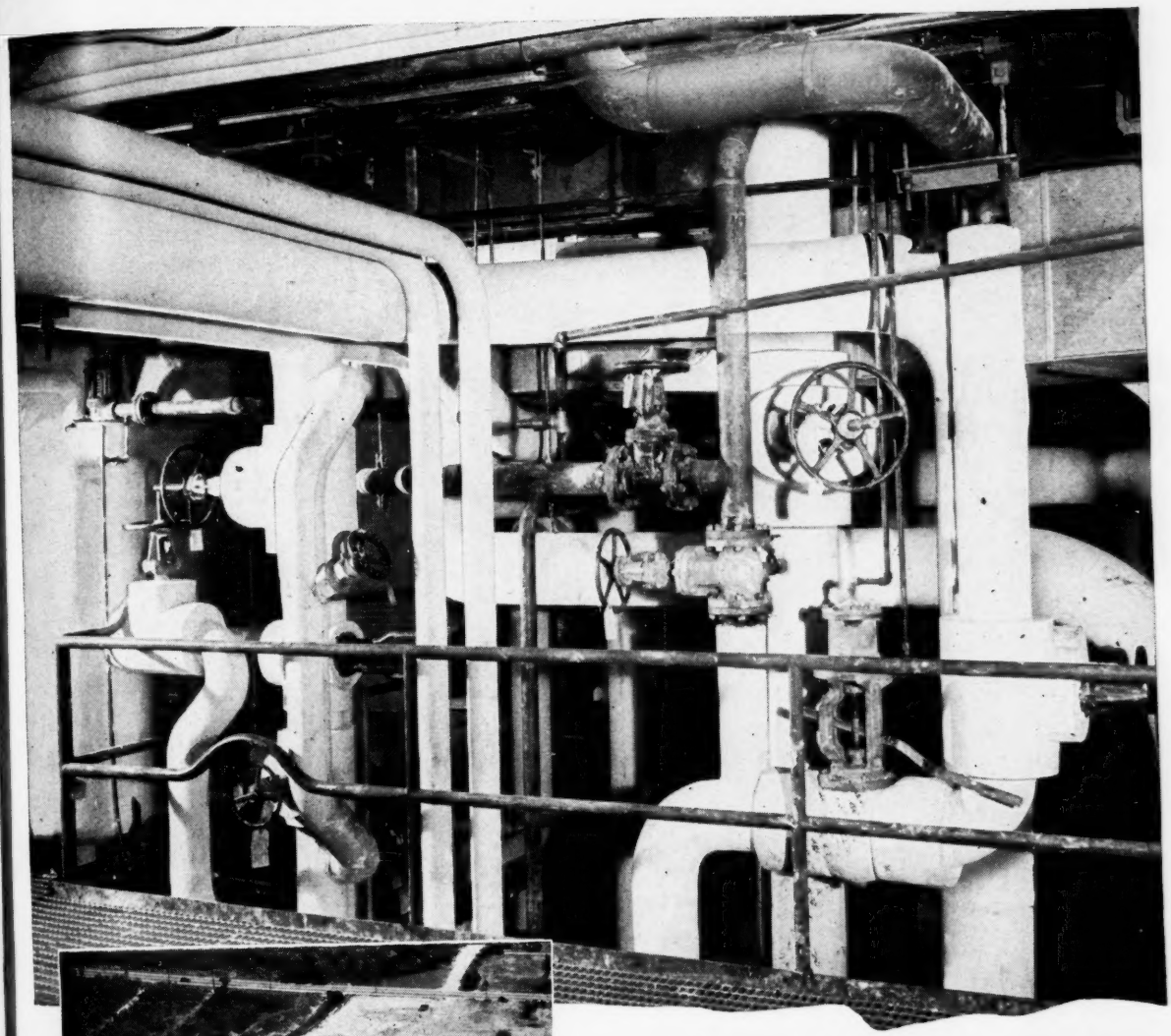
125 **Pressure Regulator**—Bulletin 1-B; description, installation, operation; list prices; sectional and installation views; parts lists; 8 pages. Atlas Valve Co.

126 **Pressure Reducing Valves**—Bulletin 1-C; sectional drawings, list prices, dimensions and weights; operation and adjustment; capacities for steam and air; 12 pages. Atlas Valve Co.

127 **Corrosion Resistant Valves**—Two bulletins, both of them on corrosion resistant vales have just been issued. One of them, a technical information bulletin covers the mechanical properties, analysis range, applications, advantages and sizes and specifications of the valves. The other is devoted to a photographic display of the installation of the valves. Alloy Steel Products Co.

128 **Pressure Reducing Valves**—Bulletin 401-A; selection of proper valve; construction; installation; capacity tables; interchangeability; dimension tables. 14 pages. Leslie Co.

129 **General Service Valves**—Bulletin E-150; valves for blow-off; fire protection, soot blower lines, acids, process etc.; descriptions; exploded views; features; dimensions weights and



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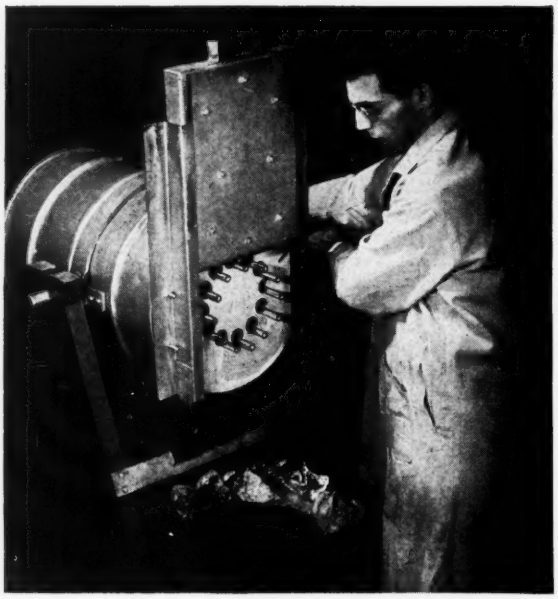

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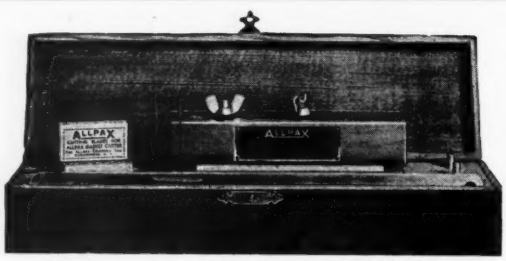

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list price tables; parts and parts list; 14 pages. Everlasting Valve Co.

130 **Valves**—Bulletin E-100; for boiler room service; photos, descriptions, parts; features; pressure rating indexes; size shipping weight and price tables; ordering information; 30 pages. Everlasting Valve Co.

131 **Multiport Relief Valve**—Bulletin 4150; complete description of valves and operating characteristics, photographs of typical installations. Engineering data includes sizing information tables, nomenclature, installation and operation, list prices of accessories, dimensioned drawings and tables of dimensions; 28 pages. Cochrane Corp.

132 **Steel Valves**—Bulletin 102; 4 page bulletin describing company's "Evrtyte" valves. Cross-sectional illustrations and tables of seat orifice sizes, prices and dimensions are given; listing of features, description of the operation of the unit and parts and prices for assemblies. Strong, Carlisle & Hammond Co.

MAINTENANCE

133 **71 Maintenance Jobs**—This guide tells how better to perform commonly occurring power plant maintenance and cleaning operations. Illustrated manual gives specific material and method recommendations for handling cleaning, degreasing, descaling, derusting, paint stripping, etc. Booklet is completely indexed and reference is made easy by colored type strips on edge of the pages; 22 pages. Oakite Products, Inc.

134 **Maintenance, Repair Tools**—Company's line of pneumatic drills, screw drivers, file and die grinders, riveting hammer and pneumatic tool accessories. Other tools include metal etchers, chucks, portable demagnetizers and many others. Completely illustrated; 24 pages. Ideal Industries, Inc.

135 **Protecting Metal**—High heat resistant coatings for protecting metal surfaces in power and processing equipment are covered in 4 page bulletin. Brief description of properties of coatings are given. The Dampney Co. of America.

136 **Condenser Tube Inserts**—Description of Flowrites; illustrated, accompanied by report of tests on Flowrites made by M.I.T. Tables and charts of test results are presented; description of how to install inserts given; 8 pages. Condenser Service & Engineering Co., Inc.

CONTROLS, METERS

137 **Pressure Controllers**—Bulletin 402; air, gas, steam or water service; when to use; selecting diapiragm regulating valve; sizing and capacity; operation; installation; ordering; specifying; dimensions; diaphragm regulating valves; 12 pages. Leslie Co.

138 **Pump Governors**—Bulletin 403-A; reciprocating, turbine-driven, motor-driven pumps; selection of governor; construction; pressure, capacity tables; insulation; sizing; specifying; dimensions; 12 pages. Leslie Co.

139 **Temperature Regulators**—Bulletin 404-A; heating or cooling service; selection of regulator; temperature and pressure ranges; installation; various types described and pictured; ordering and specifying; complete tabular material; 16 pages. Leslie Co.

140 **Damper Regulators**—Bulletin 4-A; for low pressure heating, medium pressure power and high pressure power boilers; what they do; how to specify; typical installations (drawings); adjustments; list prices; technical descriptions and parts lists; 20 pages. Atlas Valve Co.

141 **Thermostats and Relays**—Bulletin T, a 12-pg. catalog presents significant information on this company's mercurial thermostats and adjustable thermoregulators. Also included is complete data on relays, designed as companion instruments to the above mentioned. Complete descriptions of the instruments are included and the bulletin is well illustrated. Precision Thermometer & Instrument Co.

142 **Recording Flow Meter**—Bulletin 349; what it does, features, chart of rated capacity; construction and operation; installation drawings, tables of capacity; photos; 8 pages. Builders-Providence, Inc.

143 **Propeller-Type Meter**—Bulletin 350A; for main-line metering; applications, description, installation, materials of construction; features; table of capacity, shipping weights; specifications, drawings; 4 pages. Builders-Providence, Inc.

144 **Centralized Combustion Control**—Bulletin 43-605; applications to various types of fuels and burning equipment; controller, measuring elements, pilot device, power unit, etc.; 24 pages. The Hays Corp.

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145 **Combustion Meters**—Bulletin 44-550; reasons why it is; accurate, dependable, simple, rugged, easy to install, easy to maintain, speedy, easy to understand; well illustrated by explanatory diagrams; 16 pages. The Hays Corp.

146 **Feedwater Textbook**—"Mechanical Feedwater Regulation for Boilers" by Prof. E. P. Culver; principles of feedwater regulation; mechanical equipment available; differential pressure control; feed pump control; illustrations, diagrams, charts; 36 pages. Northern Equipment Co.

147 **Engineering Monographs**—Series of eight on automatic combustion control; 1. How Close Can Steam Pressure Be Controlled? 2. Why Operate Automatic Combustion Control from Changes in Steam Pressure? 3. Adapting to the Characteristics of Underfed Stokers. 4. Adapting to Spreader Type Stokers. 5. Adapting to Chain or Traveling Grate Stokers. 6. Adapting to the Characteristics of Pulverizers. 7. Adapting to the Characteristics of Oil Burners. 8. Adapting to the Characteristics of Gas Burners; total 37 pages. The Hays Corp.

148 **Draft Gages**—Bulletin 46-667; gages for indicating, recording of drafts, pressures, differentials, temperatures; pressure-draft tables; descriptions of equipment; differential units, Bourdon tube units, pointer gages, etc.; 20 pages. The Hays Corp.

149 **Draft**—Bulletin 46-472; what draft is; where it is found; how it is measured; what the draft gage tells; where to measure draft and pressure in steam plant; where to connect draft gages; how to install; drawings; 20 pages. The Hays Corp.

150 **Flue Gas Analyzer**—Bulletin 45-668; principle of operation; construction features; technique; models and prices; Burrettes—classifications and uses (table); what flue gas analysis tells us; 16 pages. The Hays Corp.

151 **Indicating, Control Systems**—What they are, what they can do; Bulletin 14B6641. Description of how transmitter, receiver and indicator of systems are constructed, how they work, their advantages and specifications. Illustrated with photographs, diagrams, charts; 12 pages. Allis-Chalmers Mfg. Co.

152 **Water Gages**—Condensed catalog, Bulletin E, of company's complete line of water gages. Each model illustrated and accompanying table gives sizing information; 8 pages. Ernst Water Column & Gage Co.

153 **Pyrometer Buyers' Guide**—Bulletin 100-1; illustrated table of contents, directions for selecting proper thermocouples, charts and diagrams. Detailed information includes complete description of material for assembled thermocouples and components; prices are listed; 40 pages. Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co.

154 **Stainless Steel Bellows**—Bulletin SSB-46; contains diagrammatic cross-section views and up-to-date information concerning the use of these bellows as equalizers, compensators, expansion joints, flexible connectors, for flow control, vapor and steam traps, thermostatic instruments, etc. Completely illustrated; 12 pages. Chicago Metal Hose Corp.

155 **Pitot Equipment**—Three section Bulletin 50; gives complete details of the use of Pitot tubes and rods, instructions in the use of the company's portable Pitot recorder, together with theory, formulae, notations and curves. Completely indexed; 20 pages. Simplex Valve & Meter Co.

156 **Manometers**—Bulletin 200; describes completely this line of fixed and portable manometers for use in water surveys and similar flow rate measurement, valuable engineering data also included. Illustrations include line drawings and photographs; 8 pages. Simplex Valve & Meter Co.

157 **Instruments, Controls for Process**—Bulletin 17; process controllers, control components, measuring components and instrument combinations briefly described and illustrated. Application data such as sizes, pressure standards and ranges are listed; 8 pages. Bailey Meter Co.

158 **Temperature Regulators**—Bulletin 7-A; six types; descriptions, list prices, tabular material, photos; list of parts; typical installation drawings; tables for finding sizes of control valves required to heat given quantity of water; 16 pages. Atlas Valve Co.

159 **Draft, Excess Air and CO_2**—Bulletin 39-341; discussion of the relation of these elements to the installation and servicing of bituminous and anthracite stokers by Arnold Soller; 12 pages. The Hays Corp.

PACKING, GASKETS

160 **Packings**—Bulletins P3, P14, P25 and P22; descriptions, tables of size and size number; tables of service for various packings, prices; 18 pages total. Greene, Tweed & Co.

Silicone News

DC SILICONE

DC Silicone Insulation Insures Motor Life!

Photo courtesy Automatic Transportation Company.

It's human nature to want to beat the drums a bit when something you've put your sweat and capital into for years begins to pan out. We've been developing Silicone Insulation for years and giving silicone insulated motors the toughest testing electrical engineers could devise. We know it's the best electrical insulation there is. That confidence is now being justified.

Automatic Transportation Company of Chicago has announced that all of their new industrial trucks will be powered by DC Silicone insulated motors and lubricated with DC Silicone grease. That means a lot to us—and to you too. Engineers estimate that 20 to 50% of manufacturing costs goes into material handling. It costs you about $300, for example, to have a truck out of service while an armature is rewound.

Automatic Transportation is taking out insurance against such losses for you, by using Silicone Insulation. That kind of insurance is really necessary because there is no control over the kind of service industrial trucks get. They may have to lift 1,500 or 35,000 pounds. They may be used constantly or only part time. They may run over smooth floors or rough ones. A 2% grade doubles the torque on the motors.

That's why Automatic uses the best insulation there is. They put the best grease they can buy in the bearings. That's the DC 44 silicone grease, because it won't bleed into the windings or brushes. They also cushion the solenoid coils with Silastic*. Taken altogether, it's a nice example of how a conscientious, enterprising company can improve its product by using Dow Corning Silicones. These heat-stable, water-proof materials are described in Catalog No. M 1-4.

*TRADE MARK, DOW CORNING CORPORATION

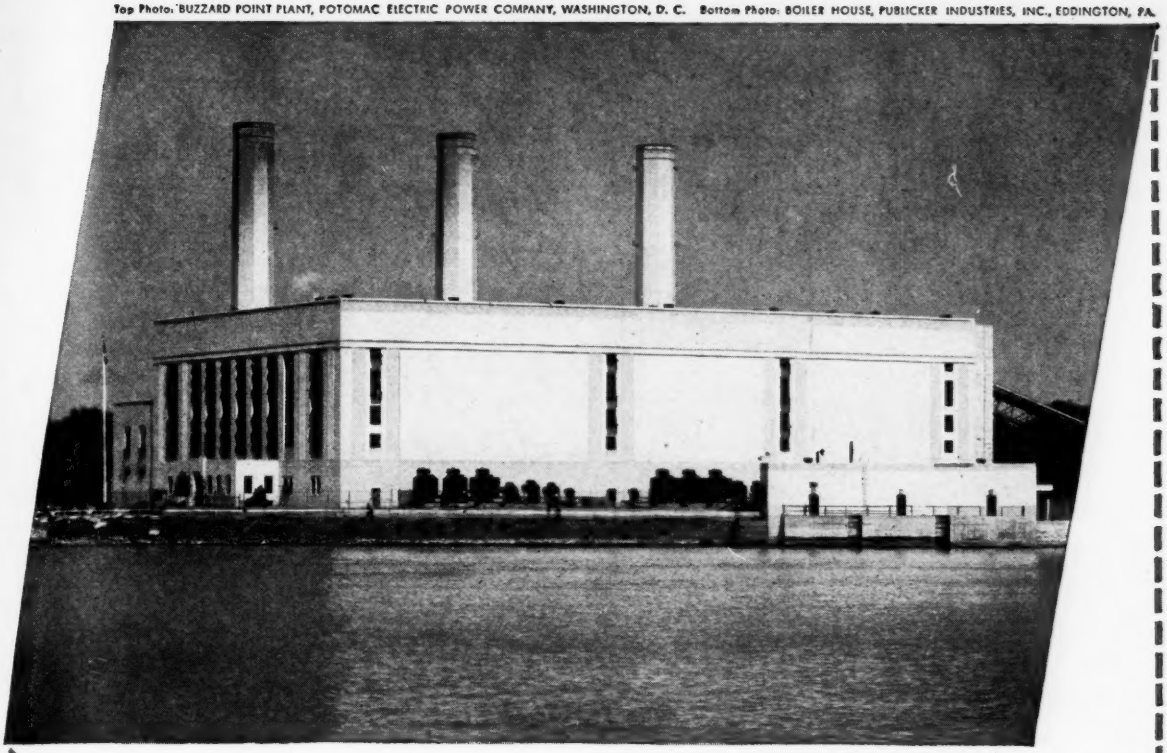
DOW CORNING CORPORATION
MIDLAND, MICHIGAN

Chicago: 228 N. La Salle St.
Cleveland: Terminal Tower
Los Angeles: 634 S. Spring St.
New York: Empire State Bldg.
In Canada: Fiberglas Canada Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning

FIRST IN SILICONES

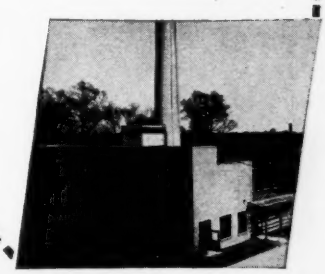
Top Photo: BUZZARD POINT PLANT, POTOMAC ELECTRIC POWER COMPANY, WASHINGTON, D. C. Bottom Photo: BOILER HOUSE, PUBLICKER INDUSTRIES, INC., EDDINGTON, PA.



SIZE IS ONLY RELATIVE

Power plants designed and built by Stone & Webster Engineering Corporation vary in size from small boiler units for industries to large central steam generating stations for utilities.

We welcome the opportunity to apply our wide experience and demonstrated ability to the design and construction of plants of any size.



STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

LOW COST DEMINERALIZED WATER

WILL REPLACE EXPENSIVE DISTILLED WATER IN THE MAJORITY OF APPLICATIONS

★ Demineralized Water suitable for many requirements demanding distilled water, can now be obtained at a fractional part of the cost of distillation. Belco deliveries are surprisingly rapid.

MODERNIZE YOUR ZEOLITE WATER SOFTENERS

The new Belco zeolite will increase the capacity of industrial softeners up to six times as much. Ideally suited for modernization of present equipment. Belco engineers are always available to help you.

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NEW JERSEY

CHECK WITH BELCO...first!

Belco

INDUSTRIAL PROCESSING EQUIPMENT SINCE 1892

161 **Packing**—Bulletin 237; photos and descriptions of use; installation drawings; standard size table; 4 pages. Warren Steam Pump Co., Inc.

FITTINGS

162 **Standards for Flanged Fittings, Valves, Flanges**—Pressure-temperature ratings, tables and charts, rating procedure, flange materials, safety factors, loading, stress formulas; 20 pages. Tube Turns, Inc.

163 **Welding Fittings**—Allowable working pressures; power, oil, district heating, refrigeration, gas and air piping; 14 tables and directions for use; 18 pages. Tube Turns, Inc.

164 **Welding Fittings**—Volumetric capacities; 2 pages of formulas for computation of capacities; 6 pages of tables; 12 pages in book. Tube Turns, Inc.

165 **Reference Tables and Data**—Bulletin 406; properties of saturated steam; velocities for fluid flow through pipe; saturated steam capacity of pipe; dimensions of extra-strong pipe; areas or circles and gal per ft of cylindrical length; engineering computations; 4 pages. Leslie Co.

166 **Unions**—Complete line of malleable iron unions and convenience unions; illustrations, descriptions, size and list prices; descriptions of materials and workmanship; 24 pages. Jefferson Union Co.

PUMPS

167 **Horizontal Duplex Piston Pumps**—Bulletin 230-1; specifications, steam end, liquid end; capacity tables for pressure service, light pressure service; dimensions, drawing, tables; 4 pages. Warren Steam Pump Co., Inc.

168 **Steam Heat Vacuum Pumps**—Bulletin 226-1; specifications, drawings, general information, tables of sizes and capacities; 4 pages. Warren Steam Pump Co., Inc.

169 **Centrifugal Pumps**—Bulletin 302-30, Revised; instructions for installation and operation; drawings, tabular material; 12 pages. Warren Steam Pump Co., Inc.

170 **Hydraulic Pressure Pumps**—Bulletin 238; specifications, sectional photos, important features; full page table of capacity, sizes, pipe sizes, pressure; 4 pages. Warren Steam Pump Co., Inc.

171 **Screw Pumps**—Recommended uses; advantages; tables of capacities and sizes; charts of test results; dimensioned drawings; suctions and discharge, packing box sizes, shipping weights tables; specifications; installation and maintenance; theoretical horsepowers; viscosity classifications; 18 pages. Sier-Bath Gear & Pump Co., Inc.

172 **Centrifugal Pumps**—Booklet describes basic action of centrifugal pumps, tells of the science of centrifugal action and the physics of pumping. Performance curves are presented. Descriptions of the company's self-priming centrifugal pumps are given and how they operate is explained Typical uses of the units are pointed out and installation and operation explained; 20 pages. Marlow Pumps.

MISCELLANEOUS

173 **Whistles and Signals**—Bulletin 421; for industrial, marine, railroad service; selection; construction; advantages; operation; ordering and specifying; 8 pages. Leslie Co.

174 **Electric Tools**—Bulletin 464; covers complete line of portable electric tools for construction and briefly describes such tools as electric hammers, drills, chisels, vibrating tools, accessories, screw drivers, etc. Prices are given. Syntron Co.

175 **Refractory Concrete**—"Lumnite for Refractory Concrete"; basic information on materials and methods used in making refractory concrete. Illustrations show application of concrete in construction of furnaces, coke ovens, etc. Another section covers concrete use in foundations, floors and structures subject to high heat; 24 pages. Lumnite Division, Universal Atlas Coincut Co.

176 **Gas Purger for Refrigeration System**—Bulletin 160; tells how to cut power costs and raise condenser capacity by proper purging of non-condensible gases. Tables of ammonia properties, advantages and complete illustrated material. Typical installations are pictured. Two pages with diagrams tell how purger operates; 8 pages. Armstrong Machine Works.

177 **Grinding Wheels**—Grinding wheels of various abrasives are illustrated and list prices presented; tables of sizes in inches are accompanied by photographs and line drawings of these various wheels. Grinding wheel dressers with list prices are shown; 32 pages. Norton Co.

Tough Maintenance Cleaning Jobs Solved the "Serviced" Oakite Way!

WHENEVER you are up against a particularly difficult maintenance cleaning problem turn it over to an Oakite Technical Service Representative. The chances are that he'll come through with a solution that's sure to please you. And why shouldn't he? After all, solving knotty cleaning problems is his job . . . has been for years.

But supposing the problem's too tough even for him, what happens? Well, he can consult the written service reports of over 150 equally experienced Oakite Technical Service men. If the answer's not recorded there he has at his disposal a corps of Oakite chemists ready to go to work in the Oakite Research Laboratory. It is there that your problem is worked on until a completely satisfactory solution is found.

Consult Oakite With Confidence

Remember, Oakite has been successfully solving every cleaning problem imaginable for nigh on 40 years. That's why we know you can consult Oakite with confidence.

OAKITE PRODUCTS, INC., 110 Thames St., NEW YORK 6, N.Y.
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Specialized Industrial Cleaning
MATERIALS • METHODS • SERVICE

Don't let maintenance costs keep your pipe lines "IN THE RED"!

Aloyco Gate Valve No. 111

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STAINLESS STEEL VALVES AND FITTINGS

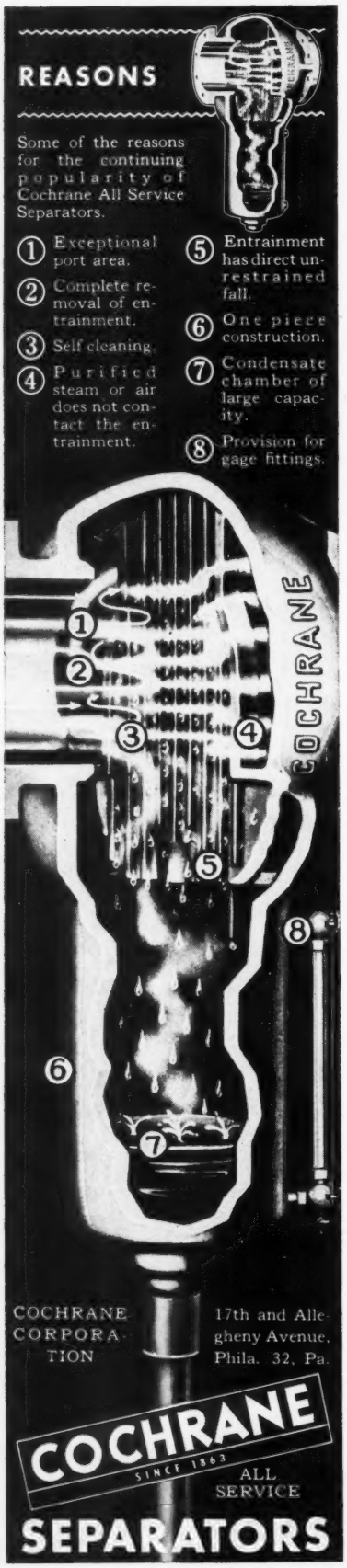
GATE, GLOBE, Y, CHECK, TANK, SAMPLING AND V-PORT VALVES
SCREWED, FLANGED AND WELDED FITTINGS

ALLOY STEEL PRODUCTS COMPANY, INC.

WEST ELIZABETH AVE. • LINDEN, N. J.

ONE BAD PROFIT LEAK IN MANY PLANTS IS VALVE MAINTENANCE—especially on pipe lines handling corrosives. "It isn't the first cost; it's the upkeep that counts"—is certainly true of valves. And the remedy is not just to specify "Stainless Steel Valves." There are many types of stainless steels and there are other corrosion-resistant materials to consider, as well. Just which is the *one best alloy* to use under given conditions of corrosion or contamination—that is a problem for specialists in the design and manufacture of corrosion-resistant valves. That's where Aloyco comes in. And that's where you can save a lot of money—by letting us select the correct alloy for valves which will stand up under the particular conditions in your pipe lines. Send for catalog.

Consult us on your requirements


REASONS
Some of the reasons for the continuing popularity of Cochrane All Service Separators.
1 Exceptional port area.
2 Complete removal of entrainment.
3 Self cleaning.
4 Purified steam or air does not contact the entrainment.
5 Entrainment has direct unrestrained fall.
6 One piece construction.
7 Condensate chamber of large capacity.
8 Provision for gage fittings.
COCHRANE
COCHRANE CORPORATION
17th and Allegheny Avenue, Phila. 32, Pa.
COCHRANE
SINCE 1863
ALL SERVICE
SEPARATORS

178 **Weldments**—Bulletin SP106 tells about the services of this company's weldry and the weldments turned out therein. The products of this weldry are shown and the text points out how flexible the method is by showing that it makes no difference if the finished product is constructed of light sheet or heavy metal . . . the resulting product can be made to exacting specifications. Graver Tank & Mfg. Co., Inc.

179 **Drop Forged Flanges**—Manufacturing processes; physical characteristics; full-page tables of illustrations, dimensions, weights and prices. Space provided for future insertions. Phoenix Mfg. Co.

MANUFACTURERS' NEWS

(*Continued from Page 164*)

GRUNERT SUCCEEDS JUHNKE AT C.E. CO.

APPOINTMENT of Arthur E. Grunert, a veteran of 38 years of service, as chief operating engineer of Commonwealth Edison Co. was announced recently. He succeeds Paul B. Juhnke, who retired from active duty January 1.

An engineering graduate of the University of Wisconsin, Mr. Grunert started his utility career in 1908 as a draftsman and subsequently became a testing engineer, boiler room engineer, efficiency engineer and superintendent of generating stations. He was promoted to assistant chief operating engineer in 1943.

Prominent for many years in committee work of various national engineering associations, Mr. Grunert won the Melville award of the American Society of Mechanical Engineers in 1932 for presenting the best paper of the year at its annual meeting. He was a captain in the U .S. Army Corps of Engineers during World War I and is a charter member of Commonwealth Edison post of the American Legion.

Also announced today by the company was the promotion of Dana D. Higgins to superintendent of generating stations. Mr. Higgins, who is an engineering graduate of Lewis Institute, entered the utility's service in 1904 as an apprentice substation operator. He has been electrical assistant to the superintendent of generating stations since 1924.

PERSONNEL CHANGES AT ALLIS-CHALMERS

JOINT ANNOUNCEMENT of the appointment of R. T. Stafford as assistant to Vice-President W. C. Johnson, and J. W. McMullen as general manager of the Pittsburgh Works of the Allis-Chalmers Mfg. Co., has recently been made by the company.

Mr. Stafford, who since 1928 has been assistant manager of the electrical department in charge of the engineering and commercial activity of the Pittsburgh Works, will operate out of New York City in his new capacity.

Mr. McMullen had been assistant manager of the Pittsburgh transformer section since March, 1945. He started with the Pittsburgh Transformer Co. in 1917, was transferred to sales work in 1925 and continued in that capacity when Allis-Chalmers absorbed the Pittsburgh firm in 1928. D. G. McArn continues as works manager of the Allis-Chalmers Pittsburgh plant.

J-M RESEARCH CENTER STARTED

CONSTRUCTION of the second and main unit of the Johns-Manville's Research Center near Bound Brook, N.J. has been started, it was announced today by Dr. C. F. Rassweiler, Vice President for Research and Development.

The first unit, comprising a product development laboratory and 10 experimental factories in one building 572 ft long and 135 ft wide and a water filtration and waste processing building is nearing completion and will be in use in the early part of 1947. It was started in September, 1945.

The second unit consists of a three story research building, 350 ft long and 67 ft wide and a mechanical and service building 288 by 100 ft. The contract for construction of this unit has been awarded the Turner Construction Company of New York, who also built the first unit.

The Johns-Manville Research Center was the first project announced in a $50,000,000

(*Continued on Page 184*)

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Cutter head speed *is the pay-off*

TOP SPEED UNDER ACTUAL SERVICE CONDITIONS is the way to judge a tube cleaner's ability to do a faster cleaning job. Lagonda tube cleaners have this speed. Their cutter heads *keep on* whirling swiftly when heavy scale tries to slow them down.

POWER—LOTS OF IT—goes right along with these racing, driving cleaners. The Lagonda motor—whether water or air-steam type—is packed full of power—and with reserve battalions of it to jump in when the going gets heavy.

RUGGED CUTTER HEADS PLAY THEIR PART in these faster, more effective cleaners. They're designed and built with the finest materials, with cutters that hold their edges, and vital parts especially heat-treated to insure proper hardness so that they stand up under this extra operating speed and power. Trackless cutters insure against tube injury as well as positively removing every trace of scale.

Use Lagonda Cleaners for tubes straight or curved, large or small. They do a faster, better, all-around job. The bulletin tells why—Write for it today.

ELLIOTT COMPANY
***Lagonda Division*, SPRINGFIELD, O.**
Plants at: JEANNETTE, PA. • RIDGWAY, PA.
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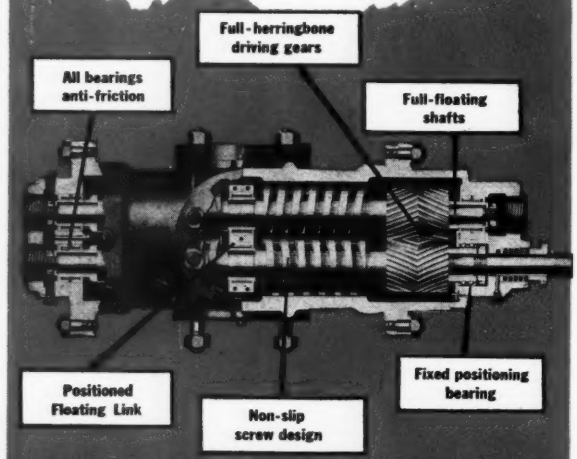
DISTRICT OFFICES IN PRINCIPAL CITIES

Y-265

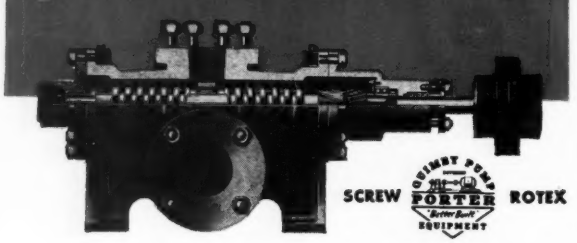
Lagonda
TUBE CLEANERS

QUIMBY
THE ORIGINAL
SCREW PUMP

Only in a Quimby do you get all these essential features



Plus—A CHOICE OF 134 TYPES IN A COMPLETE RANGE OF SIZES



SCREW — ROTEX — CENTRIFUGAL

When you buy a QUIMBY you get a pump made by a *pump manufacturer* backed by 53 years experience in designing and building pumps. Write for Bulletin S-204.

Remember, there is no substitute for a Quimby!

Quimby Pump Division
H. K. PORTER COMPANY, Inc.
PITTSBURGH 22, PENNSYLVANIA
District Offices in Principal Cities

ENGINEERS' PREVIEW

(Continued from Page 8)

WHAT'S BEHIND Studebaker's no-strike record? There are some interesting comments on this in the December 1946 issue of *Notes and Quotes* based on a study by John F. Sembower in *Industrial Relations.* It may be difficult for some people to find evidence of the plan and system responsible for the fact that Studebaker has had no serious labor trouble in its 94 years of existence. There is a surprising lack of formality about the relationships involved and no printed statement of labor policy or procedure, no codified rules of conduct, no commitments on the part of the company or its workers. But it is not what Studebaker does not do but rather what it *does* do that is important. The real secret may lie in the fact that everything it does is based on three salient features. (1) Everybody in Studebaker gives credit to a friendly, alert, home management which maintains, as a cardinal policy, the open door to all employees. (2) Foremen and supervisors on all levels are give nto understand that they must shoulder their full responsibility for industrial-relations leadership, including the handling of the unpleasant things as well as passing out the lumps of sugar. (3) The management has a cardinal maxim to the effect that "we can settle anything by talking it over," and the union and each individual employee gives every indication of fully believing this. The fact that Paul G. Hoffman, Chairman of CED (see POWER PLANT ENGINEERING February 1947), is also president of Studebaker may have some bearing. At any rate, the whole Studebaker set-up is worth considerable study to find out what makes it tick so well.

IF YOU CAN'T buy all the sugar you want these days, you may at least be interested in learning how sugar is made in a modern refinery. A detailed illustrated article on this subject, The Story of Godchaux Sugar, tells all about it in the Winter issue of *HOH Lighthouse.*

TRYING to buy a steam turbine these days? Anybody who might be able to use marine type geared units might do well to look at those offered in the January 1947 issue of *Marine Surplus Seller,* published by the U. S. Maritime Commission. One unit offered is a 8500-shaft-horsepower DeLaval cross-compound steam turbine with double-reduction, high-efficiency gear. The components are high- and low-pressure turbines, astern turbine, double reduction gear, main thrust bearing and spare parts. Two complete sets of these, including two port turbines and two starboard with matching gears are available. Another unit consists of a Westinghouse 6000-shaft-horsepower, cross-compound turbine with gear. Both units are for 440 psi normal steam pressure, 740 F normal steam temperature (785 F maximum) vacuum 28½ in. Hg. This issue of *Seller* also offers some B & W and Foster Wheeler boilers, a Cleaver Brooks distillation unit, a Heilman HB water-tube package steam generator, an Allis-Chalmers condenser, Lummus and Paracoil evaporators, marine type, and some Hays draft gages. If you are interested, get in touch with your nearest Maritime Commission sales office (the address of which we will give you on request) or write directly to Materials Disposal Section, U. S. Maritime Commission, Washington 25, D.C.

(Continued on Page 104)

Why LIQUON SODIUM ZEOLITE WATER SOFTENER is ideal for many types of plants

Various methods have been developed to remove the hardness in water that forms scale in boilers, heaters and piping, interferes with process work in many industries, and reduces the effectiveness of washing and cleaning operations.

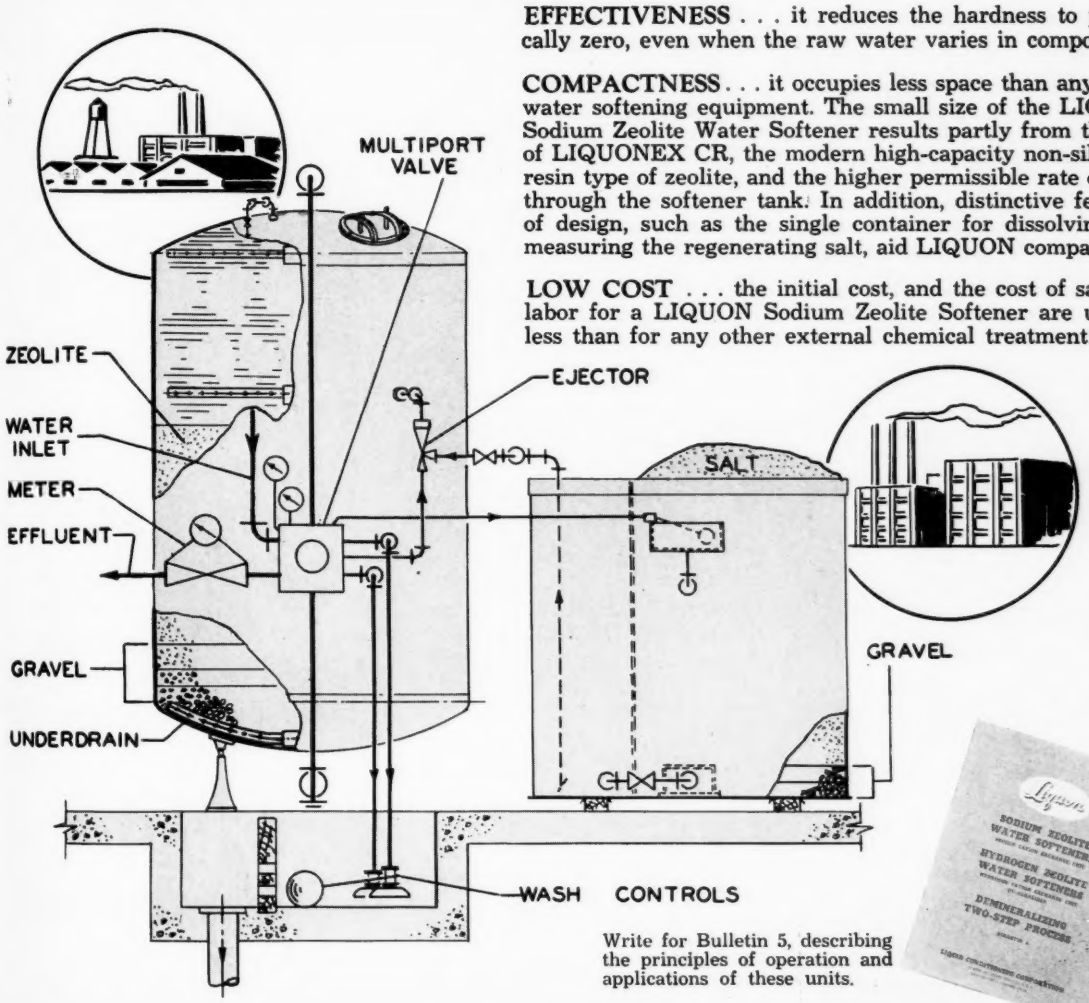
A LIQUON Sodium Zeolite Water Softener is frequently the most advantageous external chemical method of softening such water. Here are the reasons:

SIMPLICITY . . . it is the simplest method of removing hardness from a water supply . . . all operations are handled by one lever controlling a single efficient multiport valve.

EFFECTIVENESS . . . it reduces the hardness to practically zero, even when the raw water varies in composition.

COMPACTNESS . . . it occupies less space than any other water softening equipment. The small size of the LIQUON Sodium Zeolite Water Softener results partly from the use of LIQUONEX CR, the modern high-capacity non-siliceous resin type of zeolite, and the higher permissible rate of flow through the softener tank. In addition, distinctive features of design, such as the single container for dissolving and measuring the regenerating salt, aid LIQUON compactness.

LOW COST . . . the initial cost, and the cost of salt and labor for a LIQUON Sodium Zeolite Softener are usually less than for any other external chemical treatment.



Write for Bulletin 5, describing the principles of operation and applications of these units.

LIQUID CONDITIONING CORPORATION

114 East Price Street, Linden, N. J. • *Engineering Service Representatives in Principal Cities*

Liquon

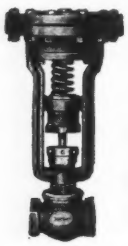
EVERY PROCESS...EVERY TYPE OF EQUIPMENT
for Conditioning of Water and Other Liquids

ATLAS

It was the great William Shakespeare who said,

"What's in a name?"

It is quite possible that in Shakespeare's day a name didn't mean much. Now, though, when a reducing valve is marked ATLAS or when *any* regulating valve for *any* service is marked ATLAS, it means that it is the best and most dependable obtainable.



Consider, for example, The

ATLAS

Type "D"

REDUCING VALVE

which we illustrate at the left. Among engineers this valve is becoming more and more popular for a number of good reasons:

First: Its unusual simplicity always insures notably accurate and close regulation of pressures.

Second: It is so easy to inspect. It is equipped with single seat renewable discs of composition or metal; stainless steel valve stem; and removable diaphragm top.

Third: It is adaptable to many uses—steam, air, or gas—and for pressures up to 175 psi.

Fourth: It is durable to a high degree. Bodies are of bronze. Screwed ends.

Fifth: Its construction gives it true balance with double port seats.

So, don't hesitate to put your regulating problems in the hands of ATLAS engineers. We have specialized solely in regulating valves for nearly a half century. We shall be glad to send you specific data on this or other ATLAS products. Make use of the coupon below.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE

291 South St., Newark 5, N. J.

Representatives in Principal Cities

☐ Without obligation, please send the "ATLAS" Reducing Valve Data and Price Book." Also, please send complete information on the following ATLAS products:

☐ Damper Regulators	☐ Pump Governors
☐ Temperature Regulators	☐ Float Valves
☐ Exhaust Control Systems	☐ Oil Control Cocks
☐ Pressure Regulators	☐ Humidity Controllers
☐ Campbell Boiler Feed Water Regulators	☐ Thermostats
	☐ Balanced Valves
	☐ Control Valves

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VALVES

(*Continued from Page 180*)

company-wide expansion program which is expected to provide 25 per cent more jobs than were available in Johns-Manville's prewar year of greatest employment, Dr. Rassweiler said.

It is planned that ultimately the Research Center will be a group of five buildings located on a 93-acre plot of land across the Raritan River from the large Johns-Manville Plant at Manville, N.J. Plans for the group of buildings are being adjusted as changing needs require.

LINCOLN ANNOUNCES NEW OFFICE LOCATION

THE LINCOLN Electric Co., Cleveland, has announced new locations of its branch offices in San Francisco, Los Angeles and Birmingham.

The new location of the San Francisco office and warehouse is at 1302 Stanford Avenue, Emeryville 8, California, under the direction of L. P. Henderson, district manager and welding engineer.

The Los Angeles office and warehouse is now located at 1500 Calzona Street, P. O. Box 7336, Station L, Los Angeles 23, California. J. B. McCormick is district manager and welding engineer.

The Birmingham district office has its new location at 113 North Ninth Street, Birmingham, with J. E. Durstine the district manager and welding engineer.

PERFEX ORGANIZATION CHANGES

THE PERFEX CORP., Milwaukee, has announced that Pres. Julius K. Luthe was elected to the position of Chairman of the Board at the December meeting of the Board of Directors. Carroll E. Lewis, Executive Vice President, was elected President and a Director at the same meeting.

It was also announced that Allen Butler, Vice President, has taken over the responsibilities formerly handled by Mr. Lewis in the Controls Division.

WARREN ANNOUNCES NEW BOSTON AREA AGENT

WARREN STEAM Pump Company, Inc., has announced that the Parkman A. Collins Co. has been appointed the Warren Authorized Agent in the territory formerly handled direct from their Boston Office. This became effective January 2, 1947. The address remains the same—75 Federal Street, Boston; Phone, HANcock 2487-2488.

LINK-BELT COMPLETES NEW PLANT IN SEATTLE

LINK-BELT CO., Pacific Division, Seattle, Wash., announces that it has completed and is now occupying its newly built plant at the corner of Sixth Ave. South & Hinds St. in Seattle.

This modern new plant contains a machine shop, larger warehouse facilities, and an up-to-date office building. It has been built to better serve the industries of the Great Northwest, either direct or through the company's factory branch stores at Spokane, Wash. and Portland, Ore.

Fred A. Koepf, district manager, and Harvey V. Eastling, manager of engineering sales, with headquarters in Seattle, direct the activities of the company in this Pacific Northwest area.

The new mailing address is 3405 Sixth Ave. South, Seattle (4), Wash. The telephone remains the same as at the old address: Main 0222.

HAYES MANUFACTURING CORP. BUYS AMERICAN ENGINEERING CO.

IT HAS JUST been officially announced that effective October 1st, 1946, the Hayes Manufacturing Corp., Grand Rapids, Mich., became owner of the American Engineering Co. and its subsidiaries. The American Engineering Company retains its corporate identity as it will not be merged with Hayes.

Rensselaer W. Clark, President, General Manager and Director of the Hayes Manufac-

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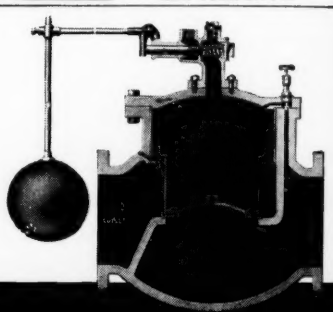

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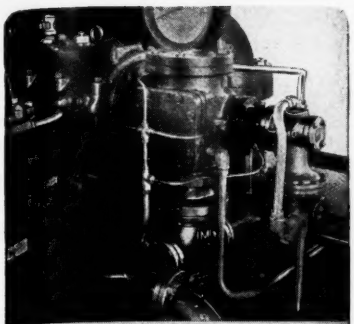

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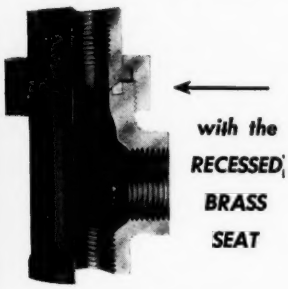

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turing Corp. for the past five years has been elected President of American. He will retain Grand Rapids as his headquarters. Acting General Manager, Edgar Washburn, has been elected Vice President and General Manager of American. He previously served five years as President and General Manager of the Balmar Corp. of Baltimore.

J. S. Bennett, who became associated with the American Engineering Co. in 1919, has been re-elected Vice-President.

Kieley & Mueller, Inc. has announced the appointment of Canadian Charts & Supplies, Ltd., P.O. Box 754, Oakville, Ontario, Canada, as its representative in the Provinces of Ontario and Quebec. This company will handle the complete line of Kontrol-Motor diaphragm valves, pressure regulators, pump governors, float valves, etc.

Thomas C. Wilson, Inc., Long Island City, N.Y., manufacturer of mechanical tube cleaners, has announced the appointment of the Harang Engineering Co., 840 Lake Street, San Francisco, Calif., as its representative in the Northern California area. Edward A. Harang, who heads the company, is a graduate of the University of Michigan with a B.S. degree in chemical and mechanical engineering. For the past ten years he has been closely allied with the power industries.

Kieley & Mueller, Inc. announces the appointment of Frabimor Equipment & Controls Co., Inc. of 5235 North Avenue, Chicago 39, Illinois as its agent in the Chicago and Milwaukee areas. The Frabimor Equipment & Controls Co., Inc. was recently organized by a group of well known regulator engineers having many years experience in the valve industry.

Snap-on Tools Corp., Kenosha, Wis. announces the opening of its thirty-ninth branch office at Charlotte, N.C. Designed to provide better service of the tool needs in the Carolinas, the new distributing center is located at 210 South Poplar Street.

MILLIONTH-OF-SECOND COUNTER

DEVELOPMENT of an electronic X-ray counter that accurately records X-rays at millionth-of-a-second speed over a wide range of intensities has been announced by Dr. Fitz-Hugh Marshall and Dr. John W. Coltman, Westinghouse research engineers.

First all-purpose tool for the measurement of X-radiation, this X-ray detector in high speed tests has approached the ultimate in sensitivity by providing exact measurement of the smallest X-ray units known as well as intense radiation.

The difficulty of measuring X-rays always has been a scientific headache, according to Dr. Marshall. The Geiger counter of the type used at the Bikini atom bomb tests to warn of radioactivity measures only low intensities of radiation. Development of such a highly sensitive and versatile instrument as this new counter, therefore, gives science a valuable tool for fundamental research as well as pointing the way to possible future industrial applications of X-ray equipment.

Dr. Marshall explains the device as an adaptation of the photomultiplier, an already existing type of electronic tube which was found to have "unsuspected talents."

The so-called photomultiplier tube which has been used in the past as a super-sensitive electric eye to measure light output can also measure X-rays at speeds as high as one millionth of a second and over a wide range of intensities.

Extremely simple in its construction, the new instrument consists of a photomultiplier tube wrapped in a sheet of fluorescent screen which is itself wrapped in black paper. While the black paper blocks out all room light, X-rays penetrate to the fluorescent screen. The tube measures the intensity of this fluorescence and can record changes in intensity as rapidly as one every millionth of a second.

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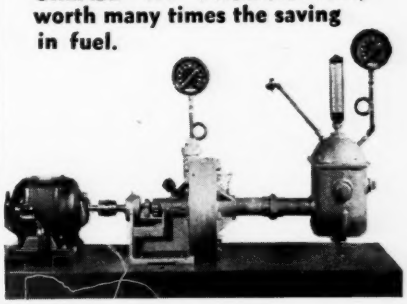

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POWER PLANT *Construction News*

Calif., Dobbins—Pacific Gas & Electric Co., 245 Market St., San Francisco, Calif., plans new hydroelectric generating plant on Yuba River at Dobbins, using same site of former Colgate power station, recently destroyed by fire. New plant will be equipped for capacity of about 33,000-hp, and is estimated to cost about $3,000,000, with switchyard, extensions in transmission lines and other facilities.

Colo., Springfield—Town Council, Springfield, has preliminary plans under way for new municipal power plant, estimated to cost about $250,000, with equipment. F. E. Devlin, 2608 East Kellogg St., Wichita, Kan., is consulting engineer.

Ga., Atlanta—Georgia Power Co., Atlanta, will carry out three power plant projects during 1947, including new 45,000-kw station near Albany, Ga., to be known as William E. Mitchell plant; addition to Arkwright station near Macon, Ga., with installation of new 40,000-kw turbine-generator and auxiliary equipment; and expansion in Atkinson plant near Atlanta, to increase capacity by 60,000-kw. This is part of $17,000,000 expansion program authorized for present year, remainder of fund to be used for power substations, transmission and distribution lines and other operating facilities.

Ind., Evansville—Southern Indiana Gas & Electric Co., 20 N.W. 4th St., plans number of new power substations and extensions in existing substations in connection with proposed extensions and improvements in transmission and distributing lines in different parts of company territory. Transformers, switchgear and auxiliary equipment will be installed. Entire project estimated to cost about $2,500,000. This is part of 1947 expansion program of company.

Kan., Topeka—Kansas Power & Light Co., Topeka, plans expansion and improvements in steam-electric generating station near city, including installation of new 30,000-kw turbine-generator, high-pressure boilers and auxiliary equipment. Cost reported close to $3,000,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

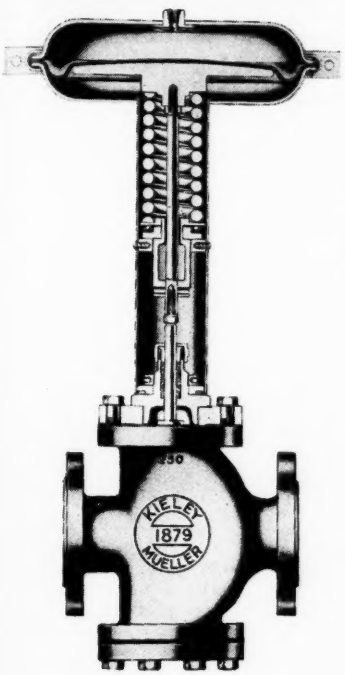
Mich., Detroit—Detroit Edison Co., 2000 2nd Ave., has approved an expansion and improvement program during 1947 to cost approximately $20,000,000, including completion of new addition to power plant at Marysville, Mich., now under way, to increase capacity by 100,000-hp; and for initial work on expansion in Trenton Channel generating station, where two new 133,000-hp turbine-generators will be installed. Additional power substations will be built and extensions made in several existing substations. Extensions and improvements will be made in transmission and distribution lines.

Mich., Jackson—Consumers Power Co., Jackson, is arranging an expansion and improvement program in generating stations, power substations and other structures during 1947 to cost approximately $33,000,000. A considerable part of fund will be used for extensions and improvements in transmission and distributing lines. Work will be placed under way soon.

Minn., Glenwood—Northern States Power Co., 15 South 5th St., Minneapolis, Minn., has tentative plans under advisement for new steam-electric generating station in vicinity of Glenwood, reported to cost close to $500,000, with turbine-generator, boiler and auxiliaries.

N.J., Sewaren—Public Service Electric & Gas Co., has authorized enlargement of new steam-electric generating station at Sewaren, now in course of construction and previously referred to in these columns. With proposed initial capacity of 200,000-kw, installation will be increased to 300,000 kw, with 3 turbine-generator units, each 100,000-kw rating, high-pressure boilers and auxiliary equipment. First section of plant is scheduled to be ready for service in fall of 1948, and entire completion late in 1949. Cost estimated approximately $38,000,000, including transmission lines. Main offices are at 80 Park Pl., Newark, N.J.

N.Y., Mount Vernon—Westchester Lighting Co., Mount Vernon, will carry out a 1947 expansion and improvement program to cost about $5,500,000 including power substations, transmission and distributing lines, and other operating facilities. Work is scheduled to begin soon.



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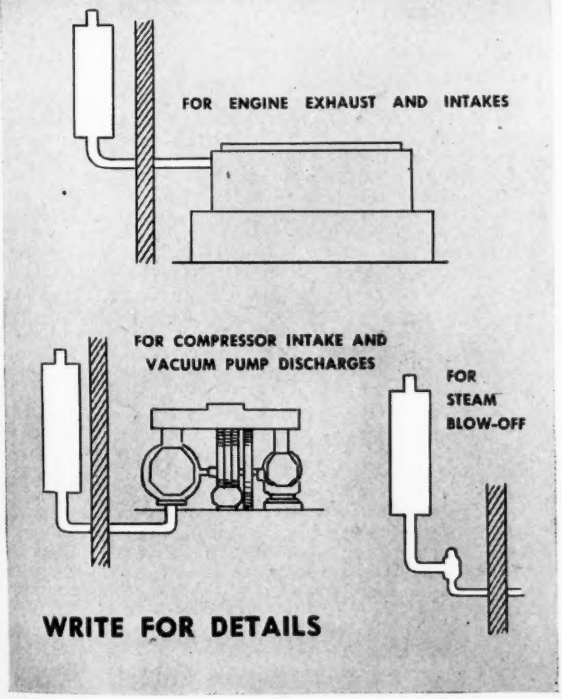

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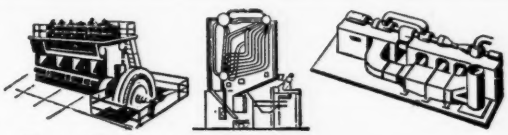

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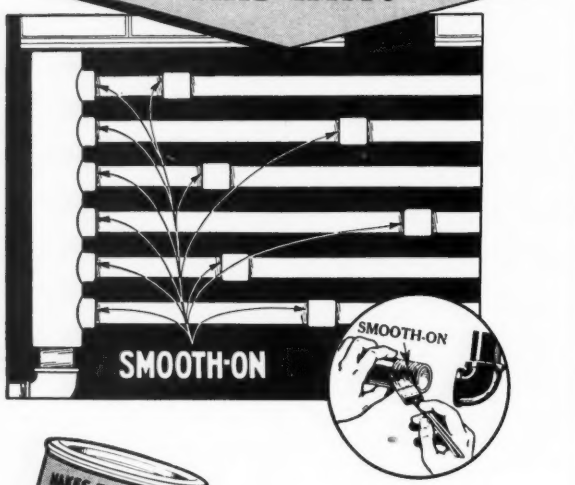

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N.Y., New York—Consolidated Edison Co., 4 Irving Pl., will carry out an expansion and modernization program at local Waterside generating station, in connection with 1947 development program. Work will include converting part of 25-cycle facilities to standard 60-cycle operation, enlargement of switching station equipment and other work. Cost estimated about $7,000,000. Company also will increase capacity of Sherman Creek plant, 201st St. and Harlem River, with installation of new 50,000-kw turbine-generator, high-pressure boiler and auxiliary equipment. Cost approximately $8,700,000.

North Dakota—Bureau of Reclamation, Region 6, Billings, Mont., plans construction of three new hydroelectric generating plants, two to be located at Crosby and Deslacs, N.D., respectively, and third at Miller, S.D. Surveys and estimates of cost are scheduled to be made in near future.

Ohio, Cleveland—Municipal Light and Power Department, City Hall, has engaged Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer, to make plans and surveys for expansion and modernization in municipal power plants, with installation of equipment for increased capacity. Entire project is reported to cost in excess of $6,000,000.

Ohio, Troy—Troy Electric Dept., City Hall, has plans maturing for expansion and improvements in municipal steam-electric generating station, including installation of additional equipment for increased output. Cost estimated close to $2,400,000. William C. Kammerer & Associates, 1900 Euclid Ave., Cleveland, Ohio, are consulting engineers.

Ore., Portland—Starr Fruit Products Co., 105 Yamhill St., S.E., canned fruit products, plans installation of electric power equipment in new local fruit-processing and canning plant, comprising several units. A boiler house is planned. Entire project to cost close to $1,000,000. Robert E. McCaughern is president.

Pa. Hatfield—Hanson Textile Co., 63 East Broad St., knit goods, elastic, etc., plans installation of electric power equipment in new one-story mill, about 100 x 160 ft, on local site. A boiler house will be built. Entire project will cost about $100,000. Work will begin at early date.

Pa., Johnston—Bethlehem Steel Co., Bethlehem, Pa., plans new boiler house, about 40 x 40 ft, at steel mill at Johnstown. Also will build pump and compressor station, 60 x 80 ft. Work will be carried out in conjunction with an expansion program at plant to cost approximately $2,000,000.

Pa., Whitaker—Whitaker Borough Council, Borough Hall, has authorized plans for new electric generating station, using Diesel engine-generator units. Cost reported about $200,000. Thomas Piatt, 528 11th Ave., Munhall, Pa., is consulting engineer.

S.C., Columbia—South Carolina Electric & Gas Co., Columbia, has made application to Federal Power Commission, Washington, D. C., for license to construct and operate a new hydroelectric generating plant on Saluda River in Lexington County, near junction of Saluda and Broad Rivers. Power dam about 1250 ft long will be built, with power station, 35 x 125 ft. Plant will be equipped for capacity of about 46,500-kw and is reported to cost approximately $4,150,000. Transmission line will be built to Lyles power substation, near Columbia.

Texas, Beaumont—Gulf State Utilities Co., Beaumont, has plans maturing for expansion in steam-electric generating station, with installation of equipment for increased capacity. Cost reported about $4,500,000. Stone & Webster Engineering Corp., Esperson Bldg., Houston, Tex., is consulting engineer.

Va., Chesterfield—E. I. duPont de Nemours & Co., Inc., Cellophane Division, du Pont Bldg., Wilmington Del., plans addition to boiler plant at mill in Chesterfield County, near Chesterfield, reported to cost close to $90,000, with equipment. CPA permission has been secured.

Wis., Green Bay—Wisconsin Public Service Corp., Bellin, Bldg., has plans under way for expansion in local Bayside steam-electric power plant, with installation of new turbine-generator, high-pressure boiler and accessory equipment. Cost estimated about $5,250,000, including transmission lines.

Wis., Milwaukee—Wisconsin Electric Power Co., 231 West Michigan St., is considering new steam-electric generating station on site near city, with initial capacity of about 80,000 kw. Installation will include a turbine generator of such rating, high-pressure boilers and auxiliary equipment. Entire program reported to cost approximately $10,000,000. Project is understood to be in a preliminary stage.

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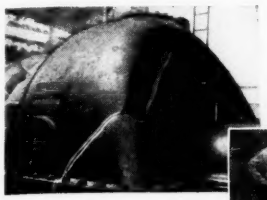

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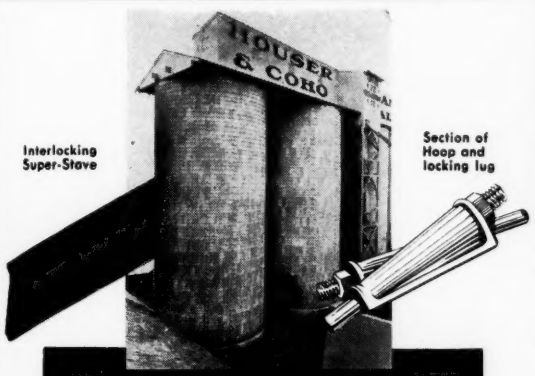

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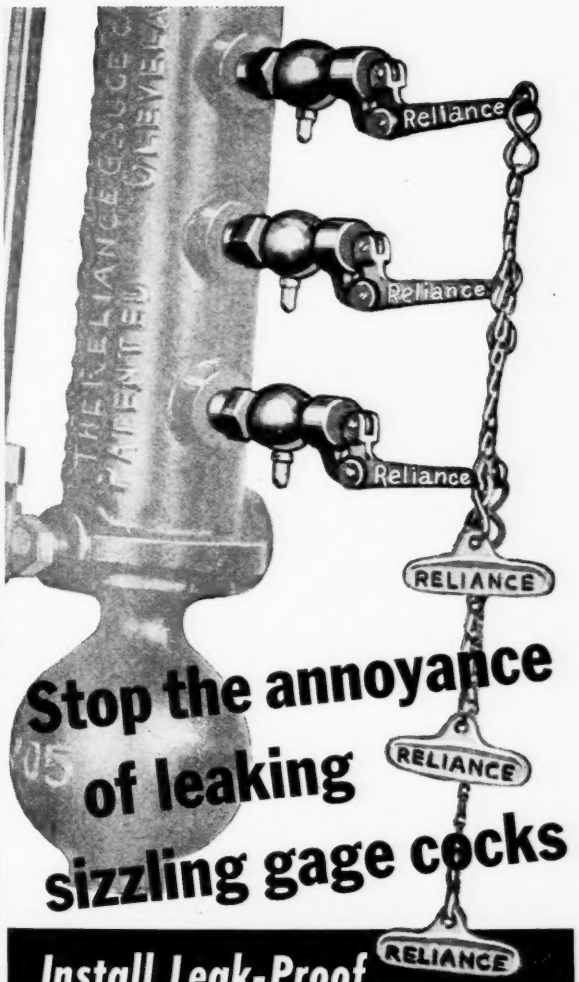

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Smoke Prevention Association of America, Proceedings of Conference on Smoke Abatement and Conservation of Fuels, held in Columbus, Ohio, October 16-18, 1945, 105 pages, 18½ by 11 in., mimeographed printing, paper binding, published by the Smoke Prevention Association of America, executive offices, City Hall Square Building, Chicago 2, Illinois. Price $2.00.

In this book of proceedings all papers presented at the conference held in the Deshler-Wallick Hotel, Columbus, Ohio, October 16-18, 1945, are printed in full together with illustrations and discussions of the papers. The subjects of these papers are as follows: District Heating; Trends in Development of Smokeless Fuels; National Fuel Conservation and Smoke Abatement; Railroad Smoke Prevention Symposium; Black Smoke and How It Can Be Eliminated; Locomotive Smoke and its Fundamentals; Meteorology and Smoke Abatement; Symposium on Dust Collection; The Growing Importance of Eliminating Atmospheric Pollution and a Description of Various Types of Preventive Devices; The Locomotive Gas Turbine; Under-Grate Air Distribution on Locomotives; Ring Blower Design and Its Effect on Draft and Steam Consumption; Combustion Controls and Smoke Abatement; Applications and Interpretation of Coal Analysis; Elimination of Nuisances Ascompanying Incineration.

Problems faced by the Smoke Prevention Association continue to grow more complicated and difficult as the fuel available for industrial and household use deteriorates in quality due to the use of the better grades of fuel beting depleted from the mines. It is, therefore, not likely that the atmosphere of cities will ever be 100 per cent clear of smoke but the association is making every effort to keep the atmosphere in a healthful condition and the proceedings of the Society may well be considered as progress reports along the various lines of fuel usage and the activities of various associations and institutions that are studying the problem continuously and reporting their findings annually to the association. Engineers who attend these smoke prevention conferences invariably find them extremely helpful particularly in the discussion of problems presented at the meetings. For those who were unable to attend the conference, the proceedings will be very helpful as they are complete and present the answers to many questions which the reader may find are bothering him.

Mainsprings of Civilization, by Ellsworth Huntington; 660 pages; illustrated; size 6 by 9 in.; cloth; John Wiley & Sons, Inc., 440 Fourth Avenue, New York. Price $4.75.

The author of this book, Research Associate in Geography at Yale University, is the man who rescued the teaching of geography in our public schools from becoming so dry that it was all ready to blow away.

In the present book he has distilled the results of 20 years of intensive study and research on all the relations between human beings, how they got the way they are and how they are related both to what they have done and where they have done it.

His book is tremendous in scope, novel in treatment and truly scientific in its attitude. It begins with a discussion of the great force that produces the mysterious thing we call civilization. The second part of the book deals with the heredity of man—why it is that various groups of people have definite but widely different characteristics, how those characteristics are affected by such things as their environment, their culture, their migration or nomadism, their religion and other factors.

The third part of the book, which forms the bulk of it, is a study of man's environment and its relation to culture and heredity. Climate, diet, density of population with all that they signify concerning disease, efficiency, mental alertness and national character are treated here in detail. There are many interesting discussions of psychological reactions (such as Indian nationalism and Japanese belligerence) as related to environment.

This book talks about many things we all have observed for years about climate, places, people, and life itself. Yet most of us never are aware that important relations exist betweeen many of these factors. Climate is not a "cause" of civilization, but if it is not, then how do you explain, for example, the high development of Iceland and the relatively low development of Newfoundland, which has much the same climate? Dr. Huntington shows what factors explain such things.

When you finish the book you'll have a better understanding of why you are a member of a "civilization" and what makes it function.

Scientific Instruments, edited by Herbert J. Cooper. First edition, 304 pages, 5½ by 8½ inches, cloth, published by Chemical Publishing Co., Inc., 26 Court Street, Department Y, Brooklyn 2, New York, 1946. Price $6.00.

This new book should be of considerable help to everyone who uses scientific instruments. It discusses a wide range of instruments designed for making physical measurements. Not only laboratory instruments but also those used in the field, in industry and commerce. In addition to the description of the various instruments, considerable space is devoted to the discussion of the principles on which they are based and to methods of measurement.

All this information is given in clear and simple language so that not only workers of specialized fields, such as chemists, physicists, biologists, physicians, students, technicians, etc., but also non-professional readers will find this book very interesting and instructive. It is for this reason too that almost any engineer regardless in what field he works should have an interest in this book. It has many diagrams and photographs which will facilitate the understanding of the mechanisms described and it describes the most up-to-date and complicated instruments.

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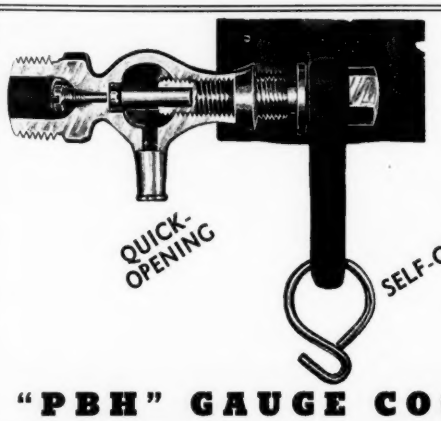

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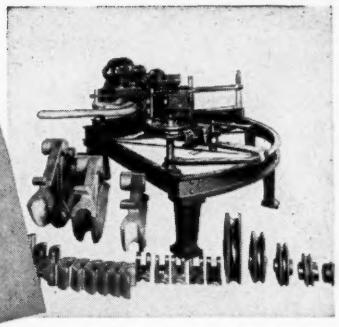

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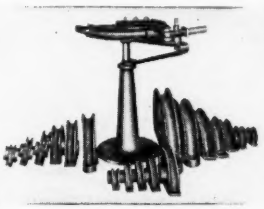

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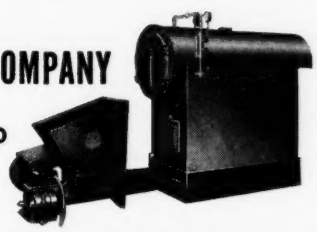

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broad types of instruments and each chapter contains a section on various specific classes. For example, Section 1 dealing with Optical Instruments has chapters on lenses, microscopes, spectroscopes, etc.

Fifteen specialists and many large firms and organizations contributed to make this comprehensive volume.

Electronics in Industry, by George M. Chute. First edition, 462 pages, size 6 by 8¼ inches, cloth, illustrated. Published by the McGraw-Hill Book Co., 330 West 42nd Street, New York City, 1946, price $5.00.

This book, written by an application engineer of the General Electric Co. at Detroit, describes and explains a wide variety of electronic equipment used in industry for the man with little technical training.

The material is presented for the users of equipment already designed and built by leading manufacturers. It is of little interest or value to the designer or builder of electronic equipment. No previous knowledge of tubes is assumed. Tubes are introduced gradually in simple operating circuits to acquaint the reader with the purpose of electronic equipment before briefly exploring the nature of the tubes themselves. Beyond simple arithmetic in example problems there is no use of mathematics at all.

One excellent feature of the book is that the circuits are traced in terms of electron flow instead of the conventional current flow. This is a welcome procedure because, as may be known, the electron flow is opposite to the ordinary conventional current flow and this in the past has been the cause of much confusion among readers who did not have proper background in electronics. The material is not arranged in the orderly classification found in most textbooks, but it aims to maintain interest. As a matter of fact, the text is based on an evening study course in industrial electronics taught in Detroit by the author for several years and sponsored by the University of Michigan Extension Service. For this reason the book is recommended to the man in industry who does not have very much background in electronics. He will find the book very valuable and easy reading.

Industrial Electric Control, by E. S. Lincoln. First edition, 374 pages, size 6 by 8 inches, cloth, published by Duell, Sloan & Pearce, Inc., New York, New York, 1946, price $3.00.

This book provides a manual for the study of the control equipment by means of which the basic voltage of all electrical apparatus is regulated. The fundametals of control by resistance, reactance, electronic means, and switching are described in the simple and straightforward text which is illustrated with over 200 diagrams and photographs.

Following the description of equipment available, examples are given for the use of each device in different processes. The reader, therefore, may obtain details of separate equipment—switches, relays, contactors, thermostats, timers, rheostats, resistors and other devices—each control mechanism described as a unit.

How to Evaluate Supervisory Jobs, by Albert N. Gillett. Copyright 1945, 34 pages of text plus job evaluation forms and complete kit of appraisal forms, size 8½ by 11 in. in three ring semi-flexible cloth board binder; published by National Foremen's Institute, Inc., Deep River, Conn. Price $7.50.

In his foreword the author states he is convinced that we are now entering an era in which human values take their proper place of importance in the business equation. He believes that the human element must be studied, weighed and evaluated, then added to and given proper proportion in our business formulas if we ever expect to arrive at a fairly accurate answer to some of the economic difficulties experienced by certain companies. This human element can be and must be reduced to a known quantity and substituted for the present general practice of almost disregarding this factor of business. One of the most difficult problems in business and industry is to properly measure supervision and evaluate its performance and contribution to the success of an organization. In brief, the purpose of this manual is first to measure in relative terms the requirements and demands of supervisory and executive positions. Second, to measure in the same relative terms the individual occupying and administering the duties and functions of this position.

This book is divided into three parts. Part I is devoted to supervisory job evaluation. It consists of eight comprehensive chapters. Part II considers supervisory job performance appraisals and has two chapters. Part III is a working kit of blank forms for evaluating your supervision. The manual is designed specifically for executives, but a careful study of its pages will assist any employee from the supervisor down to the lowest workman to improve his value to the company and to rate himself according to his qualifications for more responsible positions.

Electronics for Engineers, edited by John Markus and Vin Zeluff, First edition, 390 pages, 8½ by 11 inches, 488 figures, cloth. Published by the McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N.Y., 1945, price $6.00.

This handy reference book brings to designers, builders and users of electronic equipment a host of valuable aids. Material which has been condensed into graphs, charts and concise articles to supply readers with short cuts to more and better reference data in the electronic field. It contains a multitude of engineering aids related to the design of circuits, equipment and individual parts for radio, electronic, television, facsimile radar, sound and related vacuum tube apparatus including topics brought into prominence by acceleration of war-time electronic research. Material from many sources has been gathered together for the first time in this single convenient volume.

The material in this book represents design articles, charts and graphs selected from the complete files of Electronics Magazine. Most of this material was published in Electronics during recent years. The technical data covers 27 subjects complete with formulas, patterns, analysis, equations, tables, calculations, etc.

All the material has been carefully checked, edited and condensed where desirable to put it in the best possible form for presentation in a book. The book will be a valuable refer-

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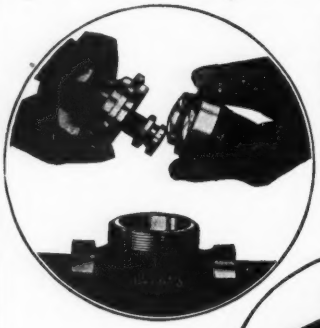

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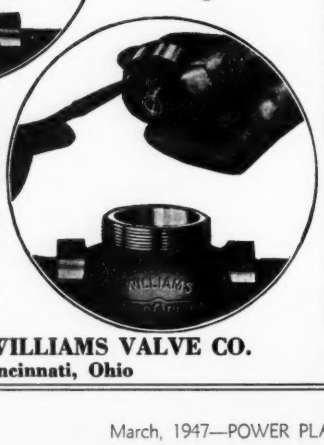

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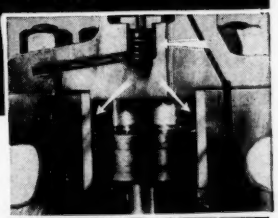

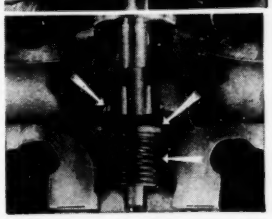

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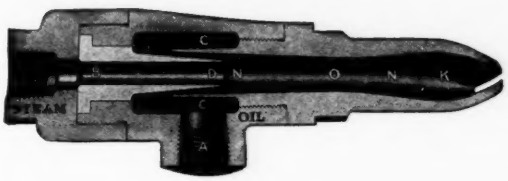

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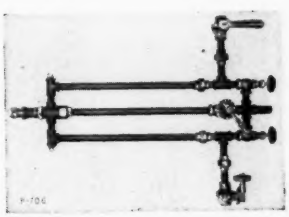

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Supplement to Book of ASTM Standards, prepared by the American Society for Testing Materials in three parts—Part I on Metals, 395 pages; Part II on Nonmetallic Materials, 250 pages; Part III on Nonmetallic Materials, 500 pages. Copyright 1946; published by the American Society for Test Materials, 260 South Broad Street, Philadelphia 2, Pa. Size 6 by 9¼, durable cloth binding with a back strap designed to match the 1944 Book of Standards; Price $4.00 per part, all three parts $12.00; Obtainable in heavy-leather bindings at an additional cost of $2.00 per part.

This supplement to the Book of ASTM Standards has been prepared to keep up to date the biennial published book of ASTM Standards in the intervening year issues supplements to each part of the book. These supplements give in their latest approved form some 230 specifications, tests and definitions which were either issued for the first time in 1945 or revised since their appearance in the 1944 book.

Part I on Metals includes over 85 standards covering ferrous and nonferrous materials. The section on ferrous metals includes steel, wrought iron, pig iron, etc.; electrodeposited coatings; also three general testing methods. Non-ferrous specications and tests include copper and copper alloy products—tubes, strip, etc.; copper and copper alloy castings; lead and lead alloys; anodic coatings; copper wire; electric furnace alloys; magnesium and its alloys; materials for radio tubes, electronic devices, and lamps; and metal powder bearings.

Part II on Nonmetallic Materials, has 50 standards which include lime, filter block, glass, soils; refractories, fire brick; thermal insulating materials; roofing materials, wood; paint, varnish, lacquer, etc.; naval stores; and thermometers.

Part III on Nonmetallic Materials includes over 95 standards. Specifications and tests cover coal, thermometers; petroleum products and lubricants; electrical insulating materials; plastics; rubber products; soaps and other detergents; naval stores; water for industrial uses; and industrial aromatic hydrocarbon.

Proceedings of the Sixth Annual Water Conference held under the sponsorship of the Engineers Society of Western Pennsylvania Civil Engineering Section has recently been issued. This Conference was held on October 22-23, 1945 in the William Penn Hotel, Pittsburgh, Pa. These printed proceedings are complete in that they carry the complete paper with discussions and comments and contain timely up-to-date and authoritative information from and by leading authorities in the country. Following is a list of the papers, addresses and authors. Experimental Studies in Boiler Scale at 1500 psi, by J. A. Holmes; How to Evaluate Data, by V. V. Kendall; German Power Plant Water Conditioning Systems, by W. W. Cerna; Behavior of Highly Concentrated Water, by C. E. Kaufman, V. M. Marcy and W. H. Trautman; Cold Water Vacuum Deaeration, by Sheppard T. Powell; Treatment and Preparation of Water in Rayon Textile Mills, by William S. Habbart; Construction and Maintenance of Water Wells, by John R. Charles; Diatomaceous Earth Filtration, by H. E. Hollberg and H. N. Armbrust; Electrolytic Water Softening for Industrial Purposes, by R. E. Briggs; Demineralization of Water by Ion Exchange, by W. D. Manring; and Fundamental Factors Affecting Design and Operation of Ion Exchange Units, by R. B. Thompson.

These proceedings are printed in a paper bound volume 8½ by 11 inches having 129 pages, which includes some advertising devoted strictly to the water treatment concerns.

Technologists' Stake in the Wagner Act, prepared and edited by M. E. McIver, H. A. Wagner, and M. P. McGirr; 260 pages, no illustrations, 6 by 9 inches; paper cover; published by the American Association of Engineers, 8 S. Michigan Avenue, Chicago 3, Illinois. Price $2.00.

There are disadvantages, as well as advantages to technologists in the Wagner Act. Most serious of all is the fact that the organization that has taken place, has, in a great majority of cases, brought technologists into heterogenous labor unions where their interests are not capably promoted. This trend is toward fragmentation and stratification, rather than toward professional unity. If unchecked, it will amalgamate the professions in a "labor front."

Despite the disadvantages, the principal emphasis of the book is on the advantages under the Act, because it is the first statutory guarantee of collective bargaining that has included technological workers in general.

Regardless of how we feel about these problems, we think every engineer in the country ought to read this book carefully before arriving at too many conclusions. It is not easy reading, for a great many of the points that must be considered in relation to the Wagner Act are purely legal, others are purely emotional and some are a combination of the two.

Five of the chapters carry the definite answers to most of the questions asked by technologists about the Wagner Act.

For example: "Is organization compulsory under the Act?" "Does not the Board uniformly exclude 'professional' and 'technical' workers from 'industrial' and 'semi-industrial' bargaining units?" "Must we accept labor union representation?" "Can we be protected from discrimination if we exercise the rights guaranteed in the Act?" References are given to combinations of chapters that bear on these —a sort of "direction finder."

There is a certain amount of rather abstract philosophy that has a bearing on such questions in addition to the definite, if not precise and fixed, principles that apply to specific situations. All these are inter-operative, so that a variety of answers is obtained.

Subsequent chapters cover the Scope of the Wagner Relations Act; Discretion Vested in the National Labor Relations Board; Questions Concerning Representation; Desires of Employees; Employee Interference and Domination; Protection from Discrimination; The Appropriate Unit; Selecting a Representative, and The Actual Process of Bargaining.

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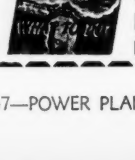

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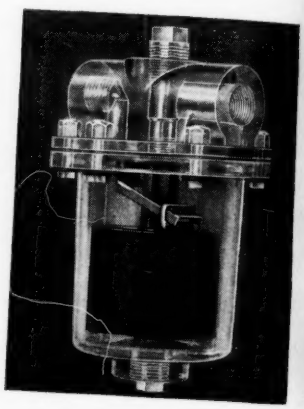

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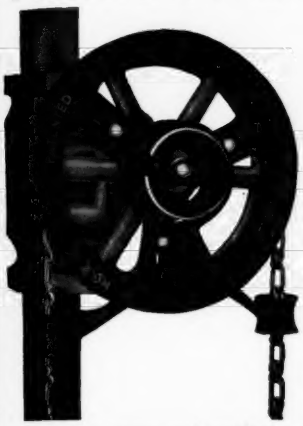

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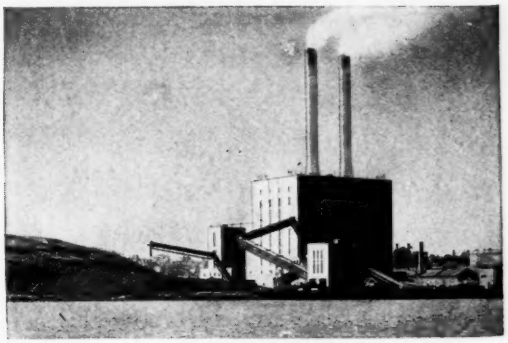

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COAL PREPARATION

FIG. 4-F

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FIG 13

FIG. 9

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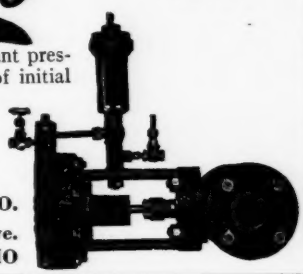

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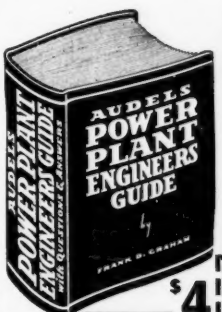

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ENGINEERS' PREVIEW

(*Continued from Page 182*)

PERMITS issued by the City of Chicago Department of Smoke Inspection and Abatement, covering all types and kinds of fuel-burning installations for commercial plants and buildings for September of this year totaled 338, compared with a total of 216 in the same month in 1945. Installation permits for underfeed stokers in September, 1946 totaled 255 compared with 183 for the same month in 1945. Permits for oil-burning installations in commercial and industrial establishments in September of this year totaled 71 compared with 28 in the like period of 1945. Permits for the balance of 12 installations covered miscellaneous equipment including four commercial gas-burners.

PERLITE, a rock formerly regarded as of little industrial value, may play an important role in meeting critical postwar requirements for durable, light-weight building and insulating materials, according to the Bureau of Mines. Resembling pumice in petrologic structure, perlite is a siliceous volcanic glass containing water of constitution which, on quick heating, yields an expanded product, says Oliver S. Ralston of the Bureau. Because of its lightness, durability, and superior heat-and-moisture-resistance properties, expanded perlite has been utilized in increasing quantities on the Pacific coast in such important industrial uses as lightweight concrete aggregates, thermal and sound insulation, refractory brick and ceramics. Recent discoveries of extensive perlite deposits in the southwestern area of the United States have further stimulated interest in this mineral. Although perlite is a comparatively new product, preliminary laboratory tests conducted by the Bureau indicate that it is capable of competing successfully with such minerals as exfoliated vermiculite, pumice, bloated-clay granules, and others, the publication states. In addition, known perlite deposits are relatively accessible to the principal consuming areas in the Western states.

YOU CAN'T cut yourself while shaving with an electric razor? Well, that is what Weare Holbrook thought too. They said it couldn't be done; but, by golly!—he did it. It all came about after his Uncle Naboth had guaranteed that if he wouldn't touch a cigarette until he graduated from college he would see that it was worth $2,527.50 to him. To make this saving, the old man finally gave Holbrook a Wade & Butcher straight-edge razor, thus saving the cost of barber shop shaves for the rest of his life. He finally succumbed, however, to the wiles of a hardware store salesman and got the electric razor. His account of how he cut himself while using it, along with his comments on the cost and quality of hair-cuts, is given in what we think is a very humorous article entitled, Bucking the Clip Joints in *The Amsco Bulletin*, Vol. 17, No. 4.